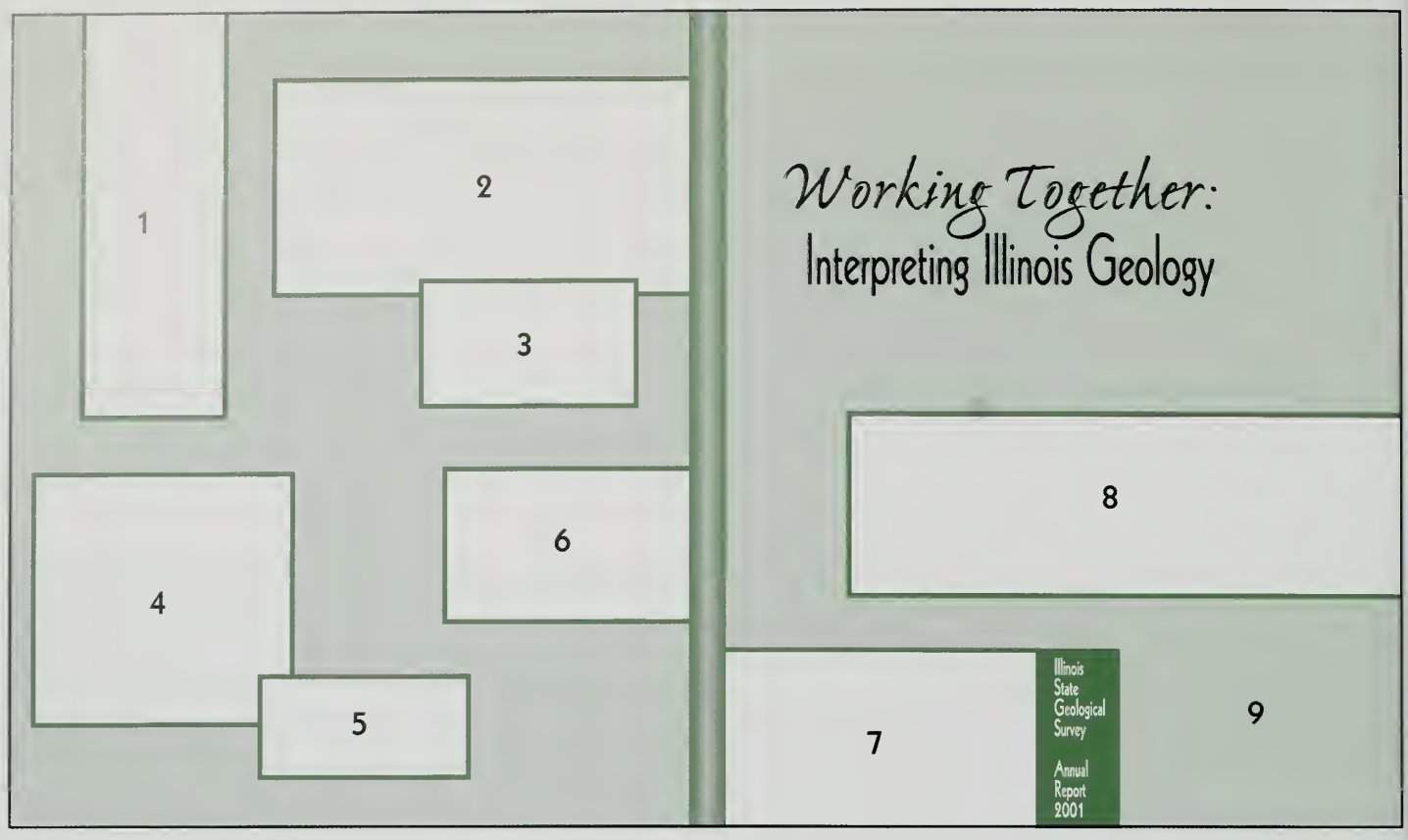
Working Together: Interpreting Illinois Geology

Illinois State Geological Survey

Annual Report 2001



COVER PHOTOS

1 David Grimley examining a loess wall at a quarry near Wood River.

2,3 Extracting limestone from Alby Quarry, Alton, Illinois.

4 Logging core on the drill site with the power probe near Antioch.

5 Examining core samples on site.

6 Massoud Rostam-Abadi and an engineer from Apogee Scientific talk prior to testing the effectiveness of a corn-based sorbent in removing mercury from coal combustion flue gases. The tests were conducted at Abbott Power Plant on the University of Illinois campus.

7 Field trip participants catch a ride between stops at Illinois Beach State Park.

8 Brad Ketterling installing a monitoring well and rain gauge at a wetland site near Perks.

9 Garden of the Gods Recreation Area, Shawnee National Forest.

Writer: Cheryl Nimz
Designer: Pam Carrillo
Photographer: Joel Dexter

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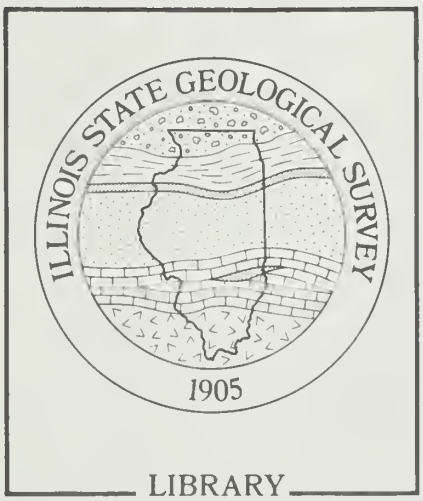
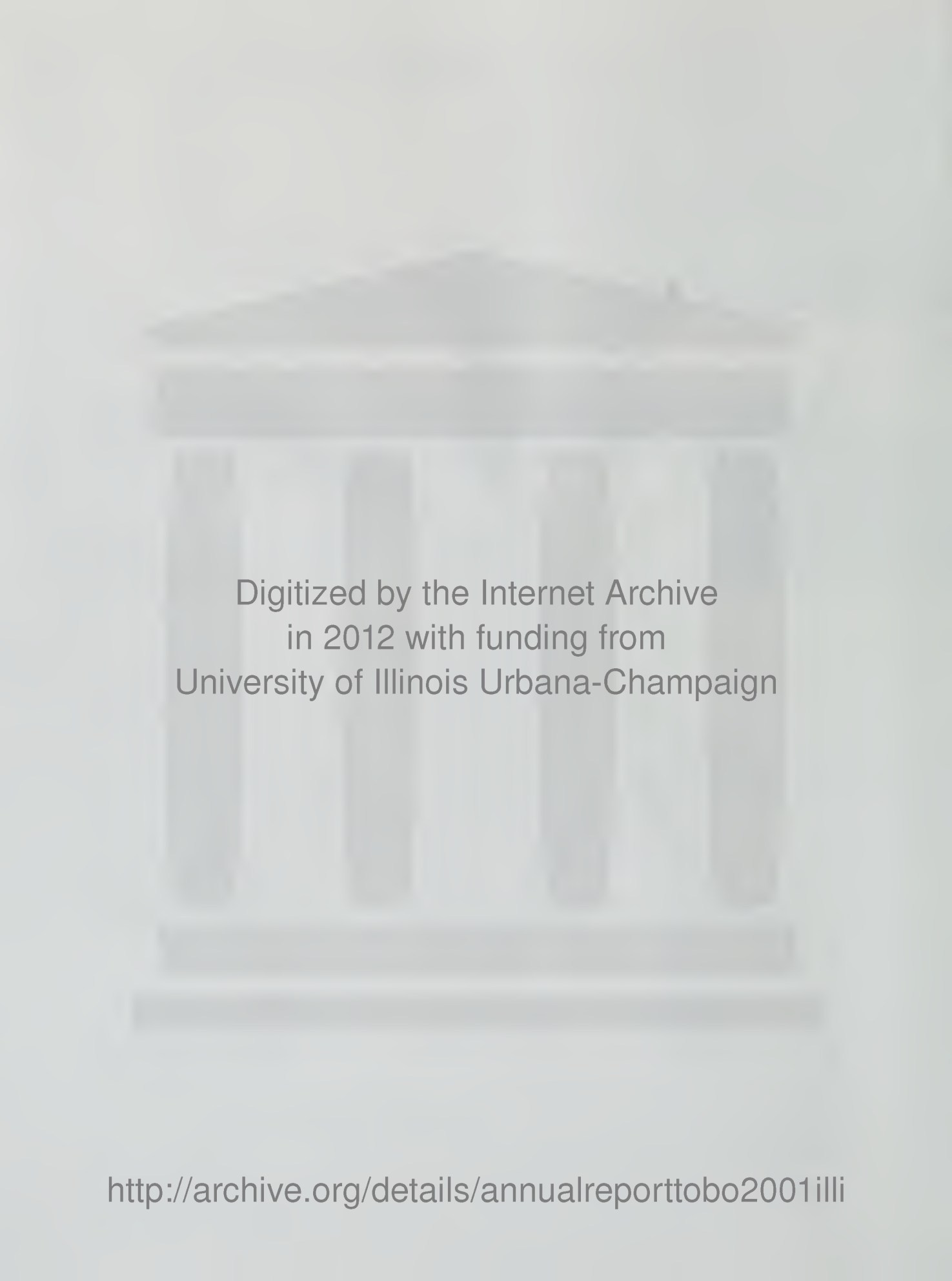


Illinois State Geological Survey Annual Report 2001

George H. Ryan, Governor
Department of Natural Resources
Brent Manning, Director

ILLINOIS STATE GEOLOGICAL SURVEY

William W. Shilts, Chief
Natural Resources Building
615 East Peabody Drive
Champaign, Illinois 61820-6964
217-333-4747



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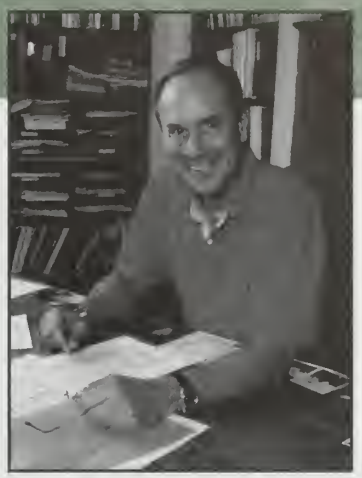
Acknowledgments

Sincere appreciation is expressed to the scientists throughout the Survey for their gracious cooperation in sharing details of their projects and in reviewing articles for this report. Special thanks are given to Daniel Adomaitis, Phyllis Bannon-Niles, Dick Berg, Mark Collier, Christine Fucciolo, Dennis Kolata, Robert Krumm, and Mike Miller for their written contributions. Technical illustrations were generously provided by Cheri Chenoweth, Mei-In (Melissa) Chou, Michael Chrzastowski, Antigone Dixon-Warren, Dennis Kolata, Ivan Krapac, Tim Larson, and Jim Miner. The photographs of Michael Barnhardt, Richard Cahill, Christine Fucciolo, Keith Hackley, Randy Hughes, Illinois State Museum, Don Luman, Jim Miner, Rodney Norby, Sam Panno, Lisa Smith, and Tim Young are gratefully acknowledged. Field experiences provided by Michael Barnhardt, Jimmie Cooper, Ilham Demir, Robert Finley, Tim Larson, David Morse, Andre Pugin, Massoud Rostam-Abadi, and Tim Young were especially beneficial.

The Challenge of Change

Change is inevitable for all public and private institutions, and the Illinois State Geological Survey (ISGS) is no exception as we strive to maintain our strength and relevance to the people of Illinois. Our senior management team is working together to identify opportunities, challenges, and future issues that can be addressed by the specialized types of research and support carried out in each of their groups. Many of us at the Survey are thriving on this change and have been energized and inspired by the opportunities offered by new funding sources and increased integration of the Survey's research in state and local government.

To the People of Illinois



Bill Shilts, ISGS Chief

Integrated Science and Teamwork

Probably the most persistent trend among publicly funded scientific organizations is the push to conduct "integrated science" research—to form teams to address the complex, pressing environmental issues that face our nation and our state. The ISGS has long worked cooperatively on teams within the Survey, with our sister state agencies, and with universities and industries of Illinois. We will continue to push most vigorously those programs and plans that require interdisciplinary teamwork to avoid overlap with other programs and to maximize the return to society on the resources it provides to us.

The Illinois Survey continues to break down our interdisciplinary barriers, which are already far less formidable than they seem to be in other similar organizations. This integration of the wide variety of earth science disciplines that are inherently part of the ISGS is far more efficient at resolving and contributing to resolution of societal issues than a focus on specialized research alone.

At the same time, we strive to stay abreast of the results of specialized research from the academic community and conduct our own directed research where we identify knowledge gaps that prevent us from serving our clients. For this reason, we need to engage as many of our scientists and support staff as possible in the proceedings of important regional, national, and international scientific meetings, such as those of the Geological Society of America or American Association of Petroleum Geologists.

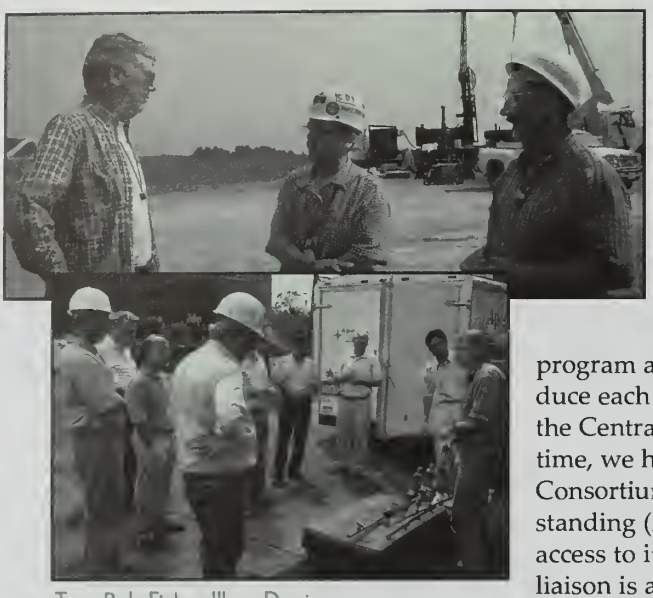
Working Together on Illinois Issues

Our Illinois Department of Transportation (IDOT) program has long provided us with a model of how teamwork and integrated science can work to address specific geoscience issues. The narrowly targeted research for site evaluations, wetland preservation, and other geologically based scientific issues required by our IDOT contracts is tailor-made for utilizing both teamwork and "integrated science." Over the years, these programs, now consolidated and institutionalized at the ISGS in the Center for Transportation and the Environment, could not have become the smoothly functioning activities they are without a dedicated commitment to teamwork by the leaders of the IDOT contracts.

Brad Ketterling, ISGS Wetlands Geology Section, adjusts a piezometer, which measures hydrostatic pressure.

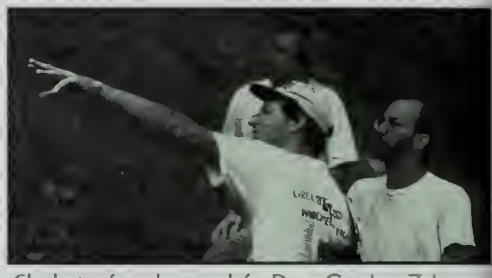
A prominent issue in earth science and state government is energy—how we manage and use our own resources and how we provide the infrastructure for the energy we must import. Natural gas is increasingly important to Illinois because we, with Michigan, lie at the nexus of the North American gas

pipeline system and store tremendous amounts of that pipeline gas in our natural geologic reservoirs. The "peaker" electric power plants that have proliferated here give us concern because of the huge water demands that these plants will create. Illinois coal researchers continue to map the state's coal resources, explore the potential for coal-bed methane, and provide Illinois with cleaner burning coal through innovative technologies, an area where we are already leaders. Addressing the energy issues of the next five years will require the input of multidisciplinary teams from the energy and environmental engineering lab, specialists in oil and gas, coal researchers, economists, bedrock mappers, groundwater experts, and others.



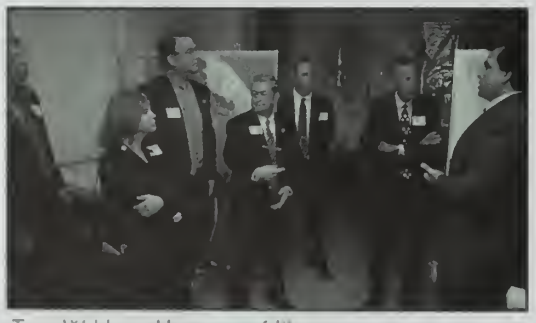
Top: Rob Finley, Ilham Demir, and Dave Morse at the coal-bed methane drilling site near Olney. Bottom: Massoud Rostam-Abadi, Jimmie Cooper, guests, and Apogee representative during setup of mercury sorbent effectiveness test.

Detailed three-dimensional geologic mapping of the upper 1,000 feet of Illinois continues to be a major goal of our program and requires the teamwork of all parts of the Survey to produce each map. We are working to expand our federal supporters of the Central Great Lakes Geologic Mapping Coalition. At the same time, we hope to promote funding of the Mahomet Aquifer Consortium. Importantly, we have signed a memorandum of understanding (MOU) with STS Consultants of Chicago that provides ISGS access to its considerable store of high-quality subsurface data. This liaison is a critical step in our ability to map Illinois effectively and economically in three dimensions. We intend to pursue more agreements with private sector firms that hold literally billions of dollars worth of subsurface data throughout the Midwest. We have also signed MOUs with the geological surveys of Finland and Canada. These agreements have already provided our agencies with a mechanism to exchange ideas and expertise on geoscience issues and research directions through visits and exchange of personnel.



Clockwise from bottom left: Dave Grimley, Zak Lasemi, and Pius Weibel examine an outcrop near Wood River.

We hope the continued pressure to restore the Illinois River and its tributaries, as well as the original lakes and drainage systems of the Chicago area, leads to new initiatives in geochemical research and mapping. Again, to accomplish these state government goals, expertise must be drawn from throughout the Survey—Quaternary geologists, groundwater researchers, field geochemists, analysts, and fluvial geomorphologists.



Tony Waldrop, University of Illinois Vice Chancellor for Research, Illinois Rep. Ricca Sloan, Rep. Rick Winkel, Rep. Tom Berns, Chris Jennings (Illinois State Water Survey), and Sen. Stan Weaver were among the Illinois legislators and other visitors listening to Rob Krumm describe the ISGS geologic mapping program.

We traditionally have been national leaders in developing curricula and programs in earth science education, and, in addition to conducting teacher workshops, we have been able to publish an innovative syllabus designed to help earth science teachers at the pre-university level develop meaningful courses. Helping Illinois' primary and secondary schools provide quality earth science programs for their students continues to be a priority for us.

The Survey has been able to attract exceptional individuals from all over the world to work together to address earth science issues in Illinois. We work to use our personal talents and training to enhance our ability to provide innovative research and increased efficiency in delivering our products. We strive to continue to embrace change—not just for change's sake—but because that change is driven by the evolution of the world we serve, by the people of Illinois.

William W. Shilts

Bill Shilts, Chief
Illinois State Geological Survey

Mapping the geology of Illinois in three dimensions and in detail continues to be a major thrust of the Illinois State Geological Survey. Although ISGS geologists are at work throughout the state, the mapping emphasis remains in and near urban areas, along transportation corridors, and in resource-rich regions. The need for up-to-date, detailed geological information is especially critical in these rapidly expanding areas.

Geologic Mapping

Every day local and regional governments and planners are faced with the formidable task of simultaneously promoting economic growth, meeting the resource needs of a growing population, and ensuring a high quality of life for generations to come. These leaders urgently need reliable information to make good decisions about the complex issues affecting our state's water, land, energy supplies, and aggregate resources. The general maps of previous generations no longer provide enough information to meet society's needs.

The Survey commitment to help clarify these societal issues by providing easily accessible, detailed, and current geologic information intensified in 1996. That year saw the beginnings of a strategy to map the geology, from surface to bedrock, of each of the state's 7.5-minute quadrangles at the scale of 1:24,000 (one inch on the map equals 24,000 inches—or 2,000 feet—on the ground). Because this task will take decades, at the earliest, high-priority areas of the state are being mapped first.

Since 1996, ISGS staff have been testing and refining modern mapping techniques as they gather geological information, classify and interpret it, and build enormous electronic databases that can be used directly or as the basis for map products. As the mapping effort matures, lessons learned are applied to subsequent efforts.

New technologies allow the ISGS to gather more kinds of information more accurately and in more detail and to record the information in easily retrievable formats. Because most of Illinois' geology lies unexposed below the surface, in complex layers of glacial drift, much of it must be interpreted from limited amounts of information. Therefore, being able to integrate the different kinds of information—such as that contained in aerial photographs, well records, core samples, geophysical logs, and seismic readings—provides a more complete view of the subsurface and improves the accuracy and usability of the map products.

The ISGS mapping teams work collaboratively and across disciplines, both within the Survey and externally. The current mapping efforts require the combined expertise of geologists, technicians, and support personnel. Financial realities support the efficiency and economic advantages of interagency teams, local-state-federal partnerships, public-private cooperation, and regional coalitions. Importantly, progress has recently been made in obtaining well records and other information from private companies. This previously proprietary information is being shared with the ISGS as the private sector sees the worth of the mapping effort. Municipalities within the same region are also starting to see the benefits of working with one another to support the state's mapping program.

The Quadrangle Map—What Is It Worth?

For the category of products that falls in the classification of "public good," it is often difficult to determine whether the benefit to society outweighs the cost to society of producing the product. Costs are realized immediately, but benefits may not be seen for years, and, even then, it may be impossible to attach a dollar value to those benefits.

Is the value of the quadrangle map the price we pay to get a copy? Is the cost of $250,000 per map too much to pay? It is becoming apparent that the true value of the geologic quadrangle map lies in avoiding past mistakes caused by a lack of information.

The cost of ignorance about geology has proven to be staggering: litigation, environmental cleanup, health hazards, damaged ecosystems, and loss of industry have all had economic consequences to the state of Illinois. The high-priority areas of the state could be mapped at a 1:24,000 scale for less than the cost of cleaning up one high-end superfund site. Careful study by ISGS economists has shown that the benefits of geologic mapping—in real dollars—are at least 25 times, and perhaps as much as 39 times, the cost of producing the information.

The Villa Grove Quadrangle serves as the first Illinois example of complete quadrangle mapping, from surface to bedrock, at the 1:24,000 scale and in three dimensions. A complete array of map products, supported by digital databases, has become available this year for this quadrangle.

Lessons Learned Mapping the Villa Grove Quadrangle

ISGS Bulletin 106, now in press, describes the current methods used to develop databases, support computer modeling, and provide remote sensing inputs. Chapters explain each of the basic geologic maps, from bedrock units to the surface, that were produced for Villa Grove. Maps derived from the basic geologic data address societal issues: groundwater resources; aquifer sensitivity; engineering properties, natural hazards, and construction materials; mineral resources; and coal resources.

How has the Villa Grove effort helped current mapping projects proceed more smoothly?

1. Team approach. The dedicated staff working on the Villa Grove Quadrangle served as a model for team cooperation. Team members consisted of geologists mapping the glacial deposits and bedrock of the quadrangle, geographic information system (GIS) specialists, database specialists, graphic artists, and other support specialists. Drilling efforts were coordinated so that bedrock and surficial geologists could obtain the information they needed from the same hole.

2. Database construction. The team learned how to construct databases to make them more useful for those making maps and for understanding the geology. Of special importance was the ability to add data easily so map products can be updated efficiently and quickly. All information obtained in the Villa Grove Quadrangle has been included in a database, on a map, or both.

3. Standards development. The project saw the beginnings of a standardized approach to geologic mapping. Proven field techniques were combined with the latest in mapping technology and computer software.

Top: Dick Berg and Ardith Hansel examine the glacial strata visible above the rocks at the Tuscola Quarry, Villa Grove Quadrangle, in Douglas County. Bottom: Tuscola Quarry in operation.

4. Methods to portray the geology in three dimensions. Digital technology has helped reduce the number of tedious manual tasks, provided scientists with views of the geology from many perspectives, and increased the accuracy of the products. Learning what options are available—and best—to portray the data effectively for a given purpose has been a complex and ongoing process.

5. Information need. The powerful nature of mapping work became especially clear. The Illinois public needs the information provided by 3-D mapping. When the information is portrayed and explained in an easily understood fashion, it sells itself.

New suburban development in Lake County (left) is encroaching on open areas, such as wetlands (right).

The geologic issues of the Antioch Quadrangle affect urban and suburban planning, especially groundwater quality, use, and protection; location of and access to construction aggregate materials; and waste disposal. The expanding urban area causes land use conflicts with high-quality wetlands, lakes, the Fox and Des Plaines watersheds, county forest preserves, state-owned lands, and agricultural and undeveloped lands.

The Antioch Quadrangle mapping project, which has attracted local and regional interest, is a great example of modern geologic mapping methods, teamwork, and interagency cooperation.

The geologic mapping of this high-priority quadrangle in Lake County, Illinois, in the Chicago Metro area is well under way. The mapping is part of the pilot phase of the Central Great Lakes Geologic Mapping Coalition, which provides partial funding support.

Working Together to Map the Antioch Quadrangle

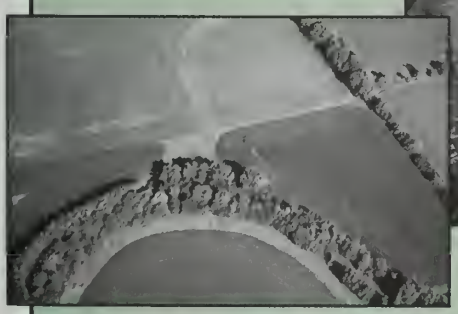
Why the Antioch Quad?

The Antioch Quadrangle has several characteristics that have identified it as one of Illinois' highest priorities for geologic mapping:

- Large urban/suburban population
- Rapid growth areas
- Recreational areas and transportation corridors
- Areas of great contamination potential
- Shallow groundwater resources
- Hundreds of wetlands and many lakes
- Surface water-groundwater interactions
- Mineral resource availability

Waiting for Information

Until the mapping is completed, many inquiries for information cannot be easily answered. For example, the municipality of Lindenhurst made a request to the ISGS for records pertaining to the drilling of new municipal wells. Lindenhurst, which was not able to obtain additional water from Lake Michigan, was seeking groundwater resources to meet its growing demands. This request, which may appear to be relatively simple, could not be answered until geologists checked to ensure that those drilling records had been verified.



From left to right: Northern Illinois farm land; Loon Lake, Lake County, Illinois; aggregate resources in southern Cook County, Thornton Quarry owned by Material Service Corporation.

Kane, McHenry, and other counties—which are seeking answers to some of the same questions important to Lake County and the Antioch Quadrangle—are watching the project with great interest.

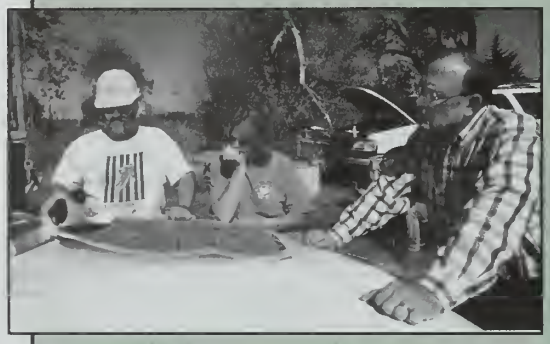
What Are the Geologists Looking for?

Geologists want to identify and map the local variability in the materials underneath the landscape. The uppermost unit in the Antioch Quadrangle, the Wadsworth Formation, is a very thick clayey glacial till to the east but thins to the west. The unit covers and protects layers of sand and gravel that may lie closer to the surface in the west than in the east. These sand and gravel layers may contain much sought-after water and construction materials. Understanding the presence or absence and the variations of such materials from place to place has both economic and societal importance.

The geologists also want to increase their basic knowledge of what lies mostly unseen by gathering as much and as many types of data as they can and by involving as many interested parties as possible. Finally, the geologists want to be able to make these data understandable and available to users, who can be confident of their accuracy.

Pilot Mapping Program for the Region

Now in its second year, this pilot program is offering ISGS geologists a unique mapping opportunity. The teams of geologists are looking at innovative ways to integrate existing borehole data with new drilling and geophysical information and then to see the data in three-dimensional (3-D) perspectives using 3-D visualization and modeling.



Mike Barnhardt, Ardith Hansel, and Gerry Glogowski examine a digital orthophotograph prior to drilling in the Antioch Quadrangle

Although the Antioch Quadrangle is the current mapping focus, five adjacent quadrangles are being examined at the same time, allowing for a broader, more comprehensive picture of the area. Geologic formations don't stop at geographic boundaries, and knowing whether formations continue, change, or disappear in neighboring quadrangles is directly relevant to characterizing the geology of the Antioch Quadrangle. As work in the area increases, the process becomes more efficient as staff become more familiar with the types of materials in the area and can make correlations between materials in different parts of the study region. Eventually, through the Coalition effort, information gained for the Antioch Quad and elsewhere in Illinois will be able to be seen in the context of the geology of the entire Coalition multi-state region, including Indiana, Michigan, and Ohio.

Checking the Facts

During year 1, which has been completed, over 16,000 (about 4,000 locations verified) historical records—mostly water-well information—were examined. Locations of the wells were verified using field, platbook, and tax parcel information, and the positions of mislocated wells were adjusted in the database so that their locations would be correctly plotted in the future.

Foreground, left to right: Antigone Dixon-Warren, ISGS geologist, works with Virgie Amacher and Tonia Vaughn, Geological Records Unit, to verify water-well data. Background, left to right: Wanda Andersen, Brent Lemke, and Randy Lipking.

This verification step is critical. Future maps or models made from these data will be very precise—but they can only be as accurate as the data used to construct them. Also, some local planning decisions may be made using only a small number of records for a small geographic area, so it is important that the records be as accurate as possible.

The USGS Hoverprobe is used to gather data about sediments from lakes in the quadrangle

Another useful historical source is digitized 1938 aerial photos overlain by 2001 cultural data. Geologists used these materials to identify geographic features, such as wetlands, that are no longer present or visible. This information helped provide data about potential drilling sites.

Existing base maps for the area were compiled, on average, 25 years ago; those out-of-date maps no longer accurately portrayed land use in these rapidly urbanizing areas. Some land cover map data were used to analyze changes in land use in northeastern Illinois.

Fortunately, ISGS geospatial analysts, in collaboration with the U.S. Geological Survey, were able to provide current, highly detailed base maps in the form of digital orthophotograph quadrangle (DOQ) images. The DOQs were also used to verify well locations.

Through use of the geographic information system (GIS) and address matching, the locations of about 4,000 wells were verified semi-automatically. Used for the first time in this way for the Antioch Quadrangle, these procedures will be useful for subsequent mapping projects, if digital tax records are available.

Breaking Down Barriers to Sharing Data

One problem that geologists encounter in urban regions is that the geology is sometimes inaccessible—covered by buildings, shopping malls, parking lots, or other structures. Yet information about these areas is essential to understanding how surface activities affect the region's water and other resources. Counties, municipalities, agencies, and public works departments—which collect and maintain their own data—have been very cooperative in sharing their geologic records.

The Lake County Department of Transportation and Department of Public Works, for example, alerted mappers to the presence of a sewer line, which might otherwise have been missed. The mapping team is trying to enlist the cooperation of Commonwealth Edison, which has records for several hundred shallow borings drilled along more than 50 miles of power line rights of way in the study area. The ISGS is currently working to contact the multiple water providers in the region and to obtain cooperative agreements with them so data can be shared.

In urban areas, a great deal of geologic information from engineering boring logs is proprietary and has been unavailable to public agencies. In a benchmark agreement, STS Consultants of Vernon Hills has agreed to contact its clients and, where they are willing, to share its proprietary geotechnical data with the ISGS from approximately 200 projects in the Antioch Quadrangle and adjacent Wadsworth Quadrangle. In return, the ISGS will digitize these records, making them more accessible and useful to STS as well as to the public. Information from these records will increase the accuracy of data for the region by providing additional points of information for areas that, in many cases, are no longer accessible for drilling. The highly consistent manner in which the data were collected makes them ideal for correlating geologic materials from site to site.

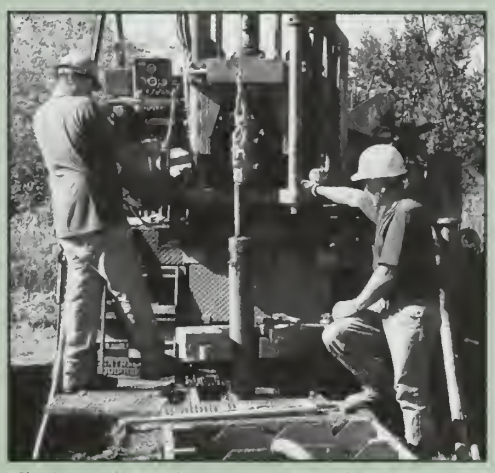
The Antioch Quad also contains many open areas, such as farms, wetlands, state parks, and forest preserves. Developers have generally been cooperative and have let ISGS geologists obtain information from their land ahead of construction. The Lake County Forest Preserve has also been very helpful in allowing non-destructive drilling on their lands.

As work in the quadrangle progresses, public awareness of the ISGS project increases. This greater visibility increases the chance that an agency or company will notify the ISGS of projects with possible implications for mapping. Everyone benefits from having the most complete database possible, which can only happen through widespread cooperation.

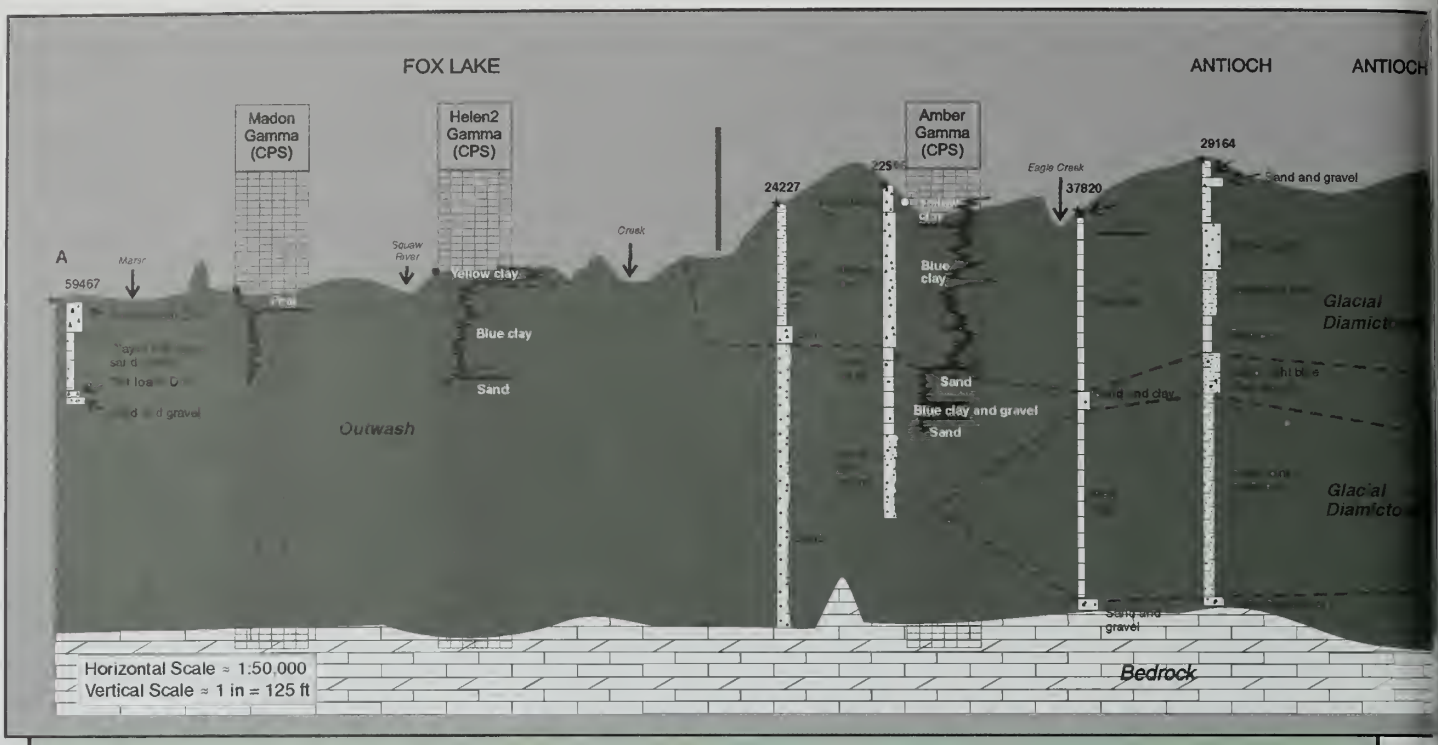
Building Confidence

Geologic specialists use both modern instrumental methods and traditional field techniques to build on the historical data. Following a long-standing practice of the Indiana Geological Survey, ISGS geologists have worked with water-well drillers, using their drill holes to collect sample sets and conduct geophysical logging of boreholes. This "piggyback" process is an economical way for ISGS geologists to obtain accurate information about the materials surrounding the holes and improve their databases.

The gamma probe, as it is lowered into a well, records minute changes in the natural radioactivity of the soil and rock, and geologists use that information to interpret the texture and mineralogical variation of subsurface materials. These accurate, repeatable readings complement—and refine—verbal descriptions and sample sets provided by the water-well drillers. And, because the drillers are looking for aquifers, geologists glean valuable information about water resources at these sites. Both the county government, which issues drilling permits, and the water-well drillers themselves have been very cooperative.

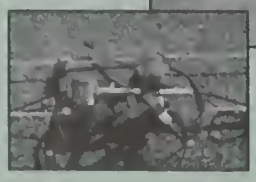


Charles Dolan and Steve Wildman drilling core to 50 feet in the Antioch Quadrangle

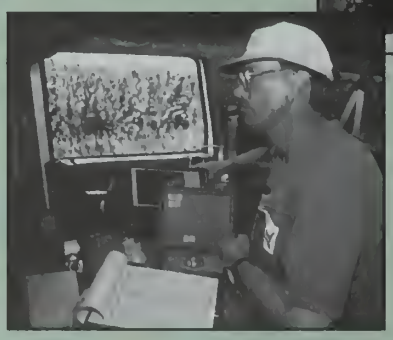


This draft cross section, which is updated as new information becomes available, helps geologists interpret the geology of the region. Data shown are obtained from water-well drill holes, which often go to bedrock, shallower drill holes, and gamma probe readings.

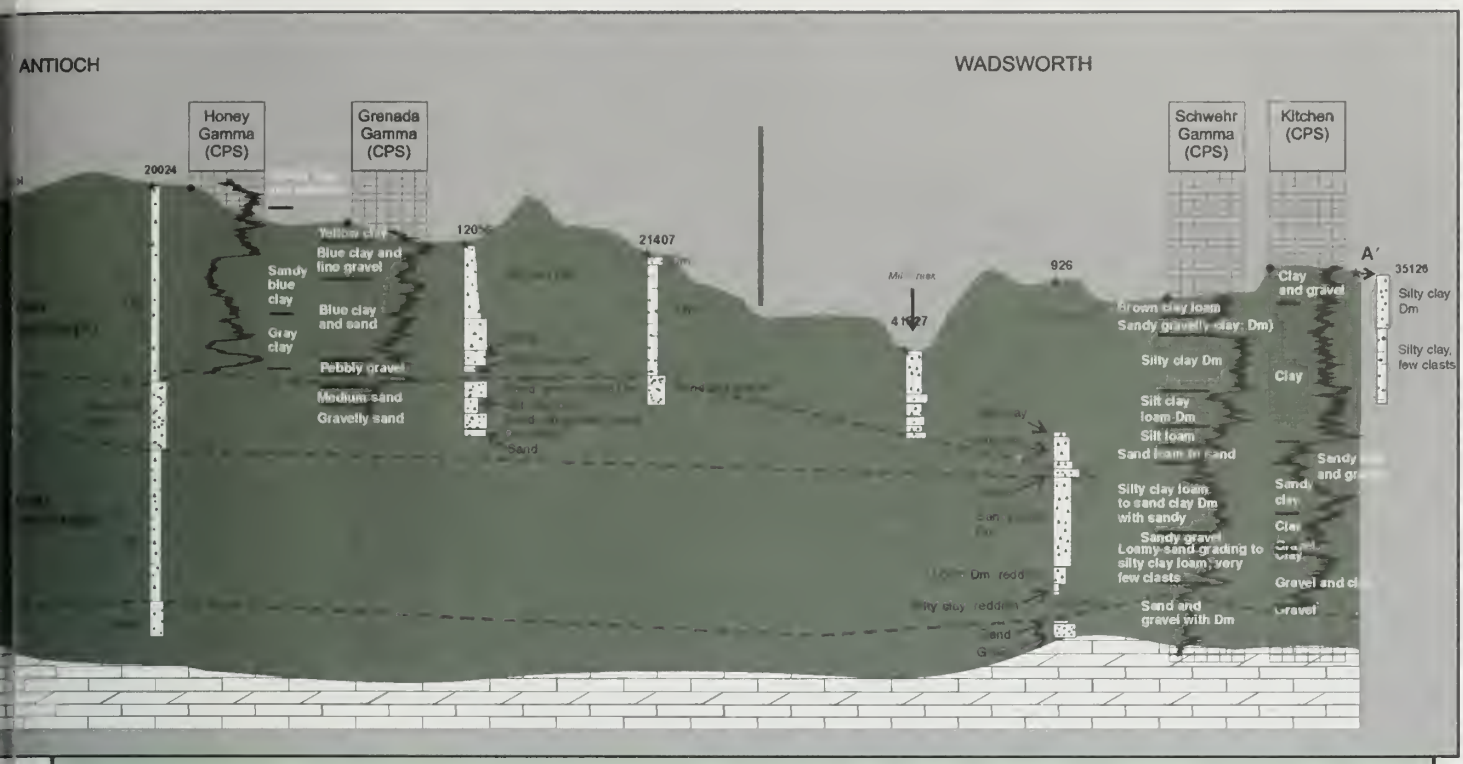
Shallow reflection seismic techniques supplement drilling information by clarifying the areas between drill holes. These seismic readings convey a "wall of information" about the materials between drill holes from the surface to bedrock. The seismic readings may suggest the need for additional drilling to resolve an unusual aspect. Each of the drill holes gives a very detailed representation of the sediment of the small area sampled. So far, about 30 boreholes have been drilled to a depth of 50 to 100 feet, and another 36 have been drilled from 5 to 40 feet deep. These shallower holes are used to obtain information from hard-to-reach areas, such as bogs, to sample near-surface sediments.



Top. Andre Pugin (foreground) works with Tim Young and Tim Larson near Olney to lay a string of geophones prior to shear wave seismic testing. Right: A mallet is used to strike a metal box producing sound waves that travel horizontally along the line of geophones. Andre Pugin records seismograph shear wave data in the truck. Bottom: Geophones used to collect shear wave data.

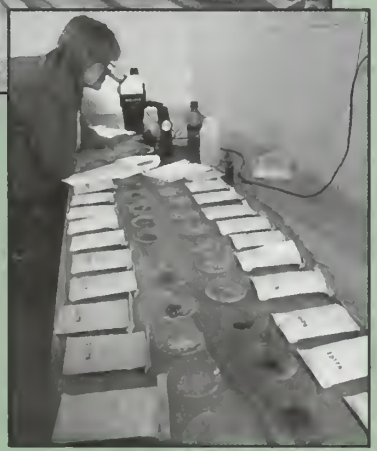


Top: Tim Young rides along next to the row of geophones placed into the ground at 10-foot intervals. Seismic reflection data are generated from sound vibrations caused when the large metal rod on the back of the vehicle hits a metal plate. Andre Pugin operates the rod-plate apparatus. Left: Tim Larson records data from the seismograph.



When It's Cold Outside

Last winter, when weather in northern Illinois often made field work impossible, geologists worked indoors describing over 200 sample sets. Water-well drillers' descriptions were converted to more meaningful sediment material characteristics. "Blue mud," for example, might be translated to "silty clay diamicton of the Wadsworth Formation." This productive time back in the office helped ensure that field data were interpreted accurately and entered into the database as quickly as possible.



When winter cold and snow (top) make working outside difficult, geologists move their work inside. Ardith Hansel (right) describes water-well samples from the Antioch Quadrangle.

Access to current information about the mapping program is especially critical for the Antioch Quadrangle, which has many geologists working on the same quadrangle, but concentrating on different aspects, such as glacial geology, groundwater, and geophysics. Now all of these geologists can work with the same verified database, which is updated frequently so each has access to all information. Monthly meetings of the team are another way information is shared.

What Lies Ahead?

Additional drilling, with a focus on sediment characterization and correlation and groundwater resources, will continue in the near future. The digital database and instructions for its use will increase. Computer modeling of the data, using the latest computer software, will present a detailed picture of the geology of the quadrangle and the region that can be used to understand how human activities are likely to impact the area.

Several map products are planned: a surficial geology map, drift thickness and bedrock topography maps, and three-dimensional maps of sediments from the land surface to bedrock. Of the derivative maps, aquifer sensitivity and groundwater resource maps are of special importance to Lake County residents.

The final report will be another way to share more complete information about the quadrangle's geology.

All of these map products can be used with confidence that the information they contain is as current and as accurate as possible.

Central Great Lakes Geologic Mapping Coalition

Since 1997, the ISGS and the Indiana, Michigan, and Ohio state geological surveys have been working together with the U.S. Geological Survey through the Central Great Lakes Geologic Mapping Coalition to accelerate the geologic mapping of the central Great Lakes region by providing an economical mechanism for sharing scientific expertise, experience, and equipment.

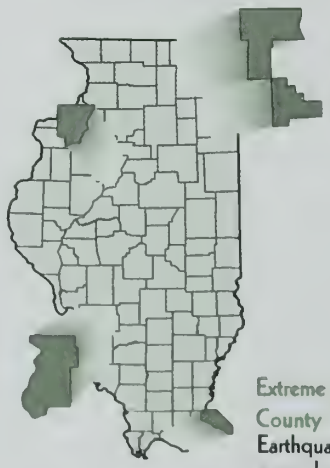
This regional cooperation makes good sense because the states share several unique geological and societal characteristics: thick deposits of glacial drift, heavy reliance on groundwater and aggregate resources, rapidly growing and shifting populations moving onto agricultural lands and sensitive ecosystems, and concentrated industrial development.

The Coalition plans to map several hundred quadrangles during the initial, 14-year intensive mapping phase of the program, if funding can be secured. The Antioch Quadrangle has been chosen as the pilot quadrangle in Illinois. During this pilot phase, mapping teams are developing needed standards for field mapping techniques, consistency of terminology, and mapping formats. These standards will make it easier for the user to interpret maps from state to state and will increase user confidence.

This year, the Coalition Forum in Chicago brought municipal, county, state, and federal agencies together with the private sector to discuss environmental, earth resource, and hazard issues and to develop a strategy to obtain the federal funding necessary to support the program. Forum speakers addressed mapping progress, mapping benefits and costs, and the relationship of geologic mapping to environment and health, economic growth and development, environmental protection, resource identification, and site exploration for construction.

The Forum clearly showed the eagerness of those agencies and the private sector for the detailed information being obtained about the region's geology. Local agencies and private consultants don't have the resources to make the regional maps that provide a context for site-specific information, which builds on regional information. Support for the Coalition mapping effort was very strong.

Where Are We Now?



Peoria County:
Urban expansion, transportation issues, groundwater, Illinois River

Chicago Metro: Lake, McHenry, Kane, and Will Counties
Urban expansion, groundwater and aggregate resources, wetland preservation

St Louis Metro East: Madison, St. Clair, and Monroe Counties
Urban expansion, karst terrain, groundwater quality, earthquake hazards, aggregate resources

Extreme southern Illinois: Massac County
Earthquake hazards, fault zones, groundwater, mineral resources

A Multiagency Partnership

In 1999, the Illinois Department of Natural Resources, the U.S. Department of Agriculture National Agricultural Statistics Service (USDA-NASS), and the Illinois Department of Agriculture (IDA) formally established a Geo-Spatial Information System Partnership for the purpose of producing statewide land use and land cover information on a recurring basis. Using current Landsat Thematic Mapper satellite imagery, specialized image processing software, and statistical algorithms designed to discriminate complex landscape patterns, remote sensing analysts at the IDNR, ISGS, the USDA-NASS, and IDA have been working closely together during the past two years to create the *Land Cover Map of Illinois 2000*, which is an updated and expanded version of the *1996 Land Cover of Illinois*. The Partnership is currently working to complete the final version of this inventory sometime this year and to plan for future updates.

Land Cover Map of Illinois 2000

The ISGS group, headed by Donald Luman, principal investigator of this multiagency initiative, received the 2001 United States Department of Agriculture Group Honor Award for Excellence, which was presented to members of the Partnership "for leveraging expertise and resources through an innovative partnership of Department of Agriculture agencies, state governments and universities to produce geospatial information system data layers in support of natural resource monitoring." Other Partnership recipients of the award include Tom Heavisides at the IDNR Office of Realty and Environmental Planning, James Hartwig at the Illinois Department of Agriculture, and Garry Kepley at the USDA-NASS.

The increased level of detail on the new map, especially for the agricultural areas comprising over 74% of the state, provides useful information to scientists and planners. Details about crop composition, watersheds, and changes in the urban fringe help provide information planners need to ensure sustainable development.

A sample of the draft version of the *Land Cover of Illinois 2000* inventory is shown here for Macon County, Illinois, at a scale of approximately 1:350,000 (1 inch equals 5.5 miles). Some of the categories have been merged together for this black-and-green rendition. Of the nearly 375,000 acres (586 square miles) that constitute Macon County, corn (lighter gray field pattern) and soybeans (darker gray field pattern) account for 43% and 33.7% of the area, respectively. Other conspicuous landscape elements include the urbanized area of Decatur (map center), which is surrounded by significant woodland (green) and grassland/open space covers, as well as Lake Decatur and the associated riparian area of the Sangamon River.

Working Together to Protect Our Environment

Working in interdisciplinary and interagency teams throughout the state, ISGS geologists obtain and share information about how land uses affect the surrounding environment, especially the impacts on groundwater quality, coastline, and wetland habitats. Geologists also study how natural processes and manmade or geologic hazards can affect populated areas.

Environmental Resources

Water

The importance of water is reflected in the many Survey efforts directed to the location, analysis, and protection of the state's groundwater resources. Locating water from aquifers can become an urgent endeavor as urban areas expand or increase their demands for water. Not all sand layers supply water, and aquifer locations can be masked by thick overlying glacial till. Even if water exists, it may not be of sufficient quantity or quality to fulfill people's needs. Modern geologic mapping data and technologies help provide the information needed to locate and develop supplies of fresh, high-quality water.

Once an aquifer is located, hydrogeologists chart groundwater flow patterns and aquifer recharge rates and analyze how land use activities affect groundwater quality and availability. This information is used to protect sensitive aquifers from pollution by industrial and agricultural chemicals, septic systems, landfill leachates, and animal waste. When water supplies are already contaminated, scientists work to analyze the contaminants and determine their sources.

Wetland and Coastal Areas

In other water-related studies, ISGS geologists provide the information needed to understand and preserve valuable and unique areas, especially wetlands and coastal regions.

Teams of scientists work to understand and share knowledge about what constitutes a wetland and how a wetland functions. This type of information is needed to preserve or restore existing wetlands and to create new ones successfully. The ways in which wetlands interact with groundwater recharge systems and watersheds draining into lakes and rivers can be critical to the health of those systems.

Coastal geologists have been studying the effects of engineering structures, shoreline development, and wave action on the Lake Michigan coast as part of ongoing efforts intended to maintain existing beach and dune areas.

Environmental Site Assessments

The Survey's environmental site assessment teams analyze specific locations around the state prior to new road and major construction projects. These assessments often unearth hidden or buried hazards that must be mitigated before the construction can continue.

Earthquakes

ISGS geologists continue to participate in regional efforts to understand and prepare for major earthquakes in southern Illinois in the area of the New Madrid Seismic Zone and the Wabash Valley Fault Zone. In the southern part of the state—the area most likely to be affected by a major earthquake event—geologists continue to map the near-surface materials to determine their potential for amplifying ground motions or to liquify during an earthquake. This new information builds on historical records, studies of ancient faults, and knowledge of the characteristics of various types of unconsolidated materials.

Groundwater Exploration

For much of Illinois, water is inexpensive, readily available, and such an integral part of daily activities that most people don't give it much thought—until water is needed but can't be found. Each year, ISGS geologists and geophysicists assist groundwater exploration efforts of individuals, companies, municipalities, farmers, well drillers, engineers, and land developers throughout the state.

Test pumping of an aquifer after its location by resistivity survey, helps prevent over pumping and dewatering of neighboring wells.

Tim Young gathers data about depth and material using geophysical logging

Village of Gifford

Gifford was unsuccessful drilling for groundwater, even though it drilled within 300 feet of existing wells, largely because of the great variability associated with the Glasford Formation outwash (sand and gravel) in the area. The ISGS conducted an electrical earth resistivity (EER) survey for Gifford using well records and geophysical log data from a nearby test drilling project to help pinpoint where to begin exploration efforts. A week-long EER survey at two sites covering 80 acres provided enough data for ISGS geologists to make recommendations that resulted in the construction and development of one test production well and two monitoring wells. Initial results appeared promising: the total thickness of sand and gravel encountered in each test hole was nearly 50 feet, twice the thickness reported in the village's existing wells.

Rick Rice pinpoints locations using the global positioning system.

Village of Flanagan

Finding groundwater in large portions of Livingston County is tough. The lacustrine "lake clay" deposits of the area are composed of fine-grained silt and clay, which is excellent material for containing landfills, but not very promising for containing aquifers. EER data are difficult to interpret because of the conductive properties of fine-grained sediment, which can mask or shroud underlying coarser grained sediment. Near Flanagan, geophysicists and geologists use well records to help locate buried bedrock valleys, which would provide increased potential for sand and gravel deposition and, therefore, increased potential for water production. A successful well completion based on EER results from a survey just southwest of Flanagan also helped direct ISGS efforts. Larger scale geophysical surveys can be time-consuming, difficult to coordinate, labor intensive, and weather dependent.

At the request of the Village of Flanagan, Illinois, the ISGS scientists conducted a large-scale EER survey covering 4 square miles along 12 miles of township and county roads. Over a 3-week period, 120 EER stations, or 1,320 soundings, were recorded over the study area in an effort to delineate sand and gravel outwash deposits. Detailed recommendations were made concerning test locations, drilling methods, sample collecting, and geophysical logging. The ISGS plans to continue support for the Village throughout the entire phase of the project, including test pumping.

Dawson Rural Water District

The engineering firm representing the Dawson Rural Water District (DRWD) contacted the ISGS to guide test drilling efforts within an existing DRWD well field. Serving three communities near Springfield, the DRWD wanted to increase water production by installing new wells near the treatment plant. The district's three existing wells demonstrated different levels of well efficiency, production, and quality, supporting the importance of locating areas for maximum production, even within areas expected to have widespread deposits of sand and gravel. After an extensive EER study, covering approximately 50 acres within the Sangamon River floodplain, four locations were recommended for test drilling. Three of these indicated a continuous thickness of sand and gravel, uninterrupted by clay or silt. Water quality is expected to be favorable as well. Test pumping and the eventual construction of a production well is expected soon. The two other successful locations were identified for future well development.

Drilling a well—located by geophysical methods—for a central Illinois community

Mahomet Aquifer Consortium

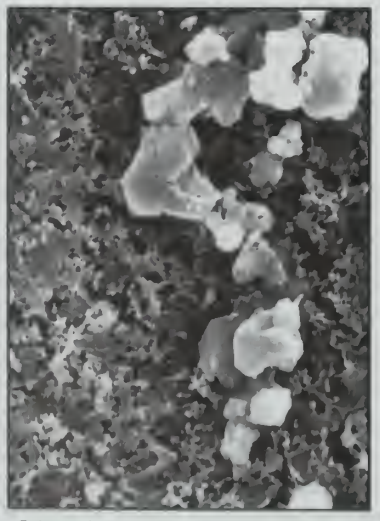
Members of the Mahomet Aquifer Consortium continue to build support for its programs and find funding sources to implement those programs. The consortium, founded in 1998 to study the Mahomet aquifer and develop a regional plan to manage this resource, persists in its efforts to ensure the aquifer's quality and productivity for future generations. Demands on the Mahomet aquifer, a vital groundwater source for 15 counties in central Illinois, are heavy and increasing as the growing communities in the region seek ever-larger supplies of water.

Consortium members—professionals representing water authorities, water companies, all levels of government, and the general public—work to increase awareness of the Consortium and to exchange information about water quality and the Mahomet aquifer. Members made presentations to various water-related service groups in Mahomet, Springfield, Bloomington-Normal, Danville, and elsewhere. Consortium representatives also met with U.S. Senator Dick Durbin (D-IL), U.S. Senator Peter Fitzgerald (R-IL), U.S. Representative Tim Johnson (R-IL), and U.S. Representative Ray La Hood (R-IL) to present information about the aquifer and to learn how to increase their effectiveness in Washington.

Keith Hackley sampling fresh core from production water wells to determine the presence of bacterial species.

Bacteria Slow Well Production

Over the past three decades, the specific capacity of some high-capacity production wells in the Mahomet aquifer has been progressively declining. The owner of the wells, Illinois-American Water Company (IAWC), contracted with ISGS hydrogeologists and geochemists to study the situation and figure out what was happening.



Calcite that precipitated in the Illinois-American Water Company well from pumping

Using geochemical modeling, the ISGS scientists suspected calcite was a possible culprit. To test this idea, they drilled two boreholes using a Rotasonic drill rig and examined core samples using a variety of microscopic, x-ray diffraction, and microbiological techniques. In addition, they analyzed suspended solids filtered from production well water samples.

Although newly formed calcite crystals were found, and calcite precipitation was exacerbating the problem, the decline in the well efficiency was primarily due to the presence of iron-depositing bacteria and their biofilm. The bacteria-related materials consisted of iron-enriched tubercles and twisted stalks that often entwined and encased mineral fragments. Downhole camera footage by IAWC during a production well renovation supported the idea that precipitated iron deposits were building up on the walls of the well screens.

In a final report submitted to IAWC, ISGS scientists suggested ways for treating the problem and for reducing its impact on the production wells.

Water Quality in Rosiclare and Elizabethtown

The municipalities of Rosiclare and Elizabethtown in southeastern Illinois contacted ISGS geochemists for help with groundwater problems. These two communities within the karst region of the Shawnee Hills area had received complaints from residents about a white material that precipitated from their municipal drinking water supplies upon heating. In addition, both municipalities had detected bacteria in their water samples.

The Mississippian age rocks in the region are overlain by thin loess soil less than 3 meters thick, which offers very little filtering ability. The limestone bedrock underneath the loess is fractured and faulted and contains sinkholes, caves, and other cavities that allow rainwater and soil water to move quickly through it. This terrain—known as karst terrain—is especially vulnerable to surface contaminants because surface water is directly connected to the aquifer. Water from precipitation plunges very rapidly down sinkholes and into the shallow karst aquifer, with little or no filtration or time for chemical and biological degradation of water-borne pesticides, oil, and other contaminants.

Base of the Rosiclare water tower.

The groundwater geochemists collected water samples from wells of both cities and analyzed them for cations, anions, bacteria, and tritium. The white precipitate was found to be calcium carbonate, which is not a health threat to consumers.

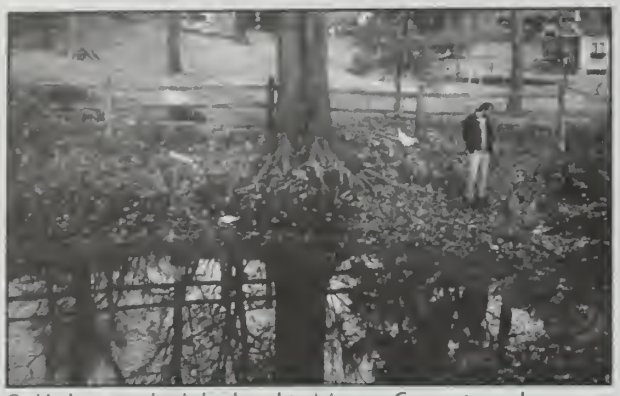
However, high-nitrate concentrations in Elizabethtown's water suggested contamination from surface-applied agrichemicals. The bacteria present in groundwater samples from both cities also suggested contamination from the surface, probably from animal wastes.

As expected, tritium analyses suggested that water recharge was relatively recent. The geochemists also thought that contaminants and recharge rates might fluctuate depending on the time of year. Seasonal analysis might confirm this and indicate also whether the Ohio River posed a threat to the water quality of the wells during its spring flooding events.

To add to these natural problems, poor well construction practices could allow surface-borne contaminants to seep into the wells and contaminate otherwise good-quality groundwater, especially if well casings were installed incorrectly or were not deep enough to prevent input of contaminated water from the shallow karst aquifer.

Geochemists were able to make preliminary recommendations to the communities. First, they recommended well renovation as soon as possible to prevent further contamination of groundwater. For wells not renovated in the near future, the geologists recommended sampling water at least quarterly (seasonally) for a full year to determine cations, anions (including nitrate), field parameters, ammonia, pesticides, bacteria, and tritium. This suite of samples would provide additional information about recharge and the degree of well contamination.

The peaceful-looking Ohio River can pose a threat to drinking water quality from wells inundated during flooding events.



Sinkhole in resident's backyard in Monroe County is used as a discharge for three septic systems. The effluent flowed directly into the owner's well.

ISGS researchers, in cooperation with the Illinois State Water Survey, have been studying groundwater quality and the geochemistry of nitrate sources in the sinkhole plain of Monroe County in southwestern Illinois. Previous studies have shown that about 18% of the wells in the area have nitrate concentrations higher than that allowed by the U.S. Environmental Protection Agency, yet about half of the area's residents get their drinking water from the shallow aquifer in karst terrain.

The study showed that the dominant sources of nitrates could be determined by measuring the ^{15}N and ^{18}O of the dissolved nitrate in the discharge water of springs and wells in karst terrain. Contaminants in geologically vulnerable Monroe County can come from diverse sources. Agriculture, both livestock and row crops, can be a source of excess nitrogen in both land and water. Septic systems can leach organic material, bacteria, and nitrogen into the groundwater. In addition, private wells in the area commonly have been constructed improperly without casings or with ineffective casings, making them easily contaminated.

Groundwater Quality in the Sinkhole Plain of Monroe County

To understand how groundwater was being contaminated, the scientists collected water samples from 10 karst springs and 17 wells, during different seasons, and then analyzed them for chemical, isotopic, and bacterial composition. Chemical and isotopic analyses showed that surface and soil water rapidly infiltrated the karst aquifer and that water constituents varied by season. Other analyses showed that bacterial concentrations in the springs and most of the wells were greater than allowed by law for drinking water.

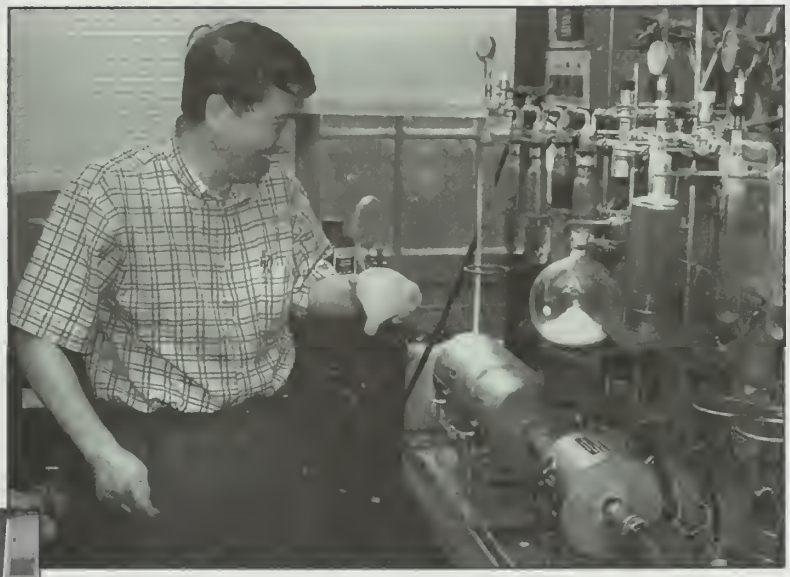
Hue-Hwa Wang (left) records data as Keith Hackley measures the discharge of a spring in southeastern Illinois.

Atmospheric nitrogen, synthetic and mineralized fertilizer, organic nitrogen in soil, and sewage can all contribute nitrogen. Because different nitrogen sources have different isotopic compositions, isotopic analyses can help differentiate between sources. For example, ^{15}N of fertilizer has an isotopic composition of near zero, but animal waste is typically +8 to +22 parts per thousand. And, since the isotope values of nitrogen can be affected by denitrification, the scientists also look at oxygen values. The combined values provide a better idea of the nitrogen's origin than if either isotope were studied alone. Chemical and bacterial analyses augment these isotopic data.

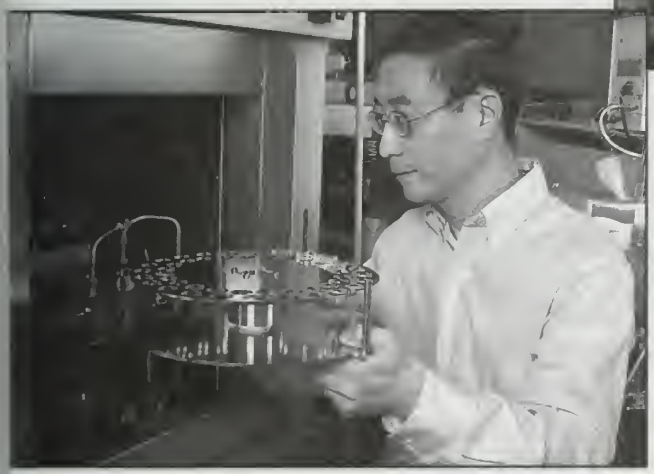
Geochemist Keith Hackley obtaining water sample from a spring in Monroe County in southern Illinois.

These combined analyses are especially useful in determining the sources of contaminants in springs, which receive materials from the entire watershed and, thus, are more difficult to analyze. Understanding where contaminants originate helps in evaluating the impact of local land use practices on groundwater quality.

The ISGS Radiocarbon Dating Laboratory's performance won recognition again. The ISGS Laboratory received a perfect score in the Fourth International Radiocarbon Inter-Laboratory comparison program, sponsored by the International Atomic Energy Agency (IAEA). The ISGS results on all ten unknown samples were statistically identical (within one standard deviation) to the IAEA consensus values. Those values were derived from statistical evaluation of the results reported by 89 participating laboratories worldwide.



Chao-Li (Jack) Liu at work in the ISGS Radiocarbon Dating Laboratory.



In order to determine their carbon and oxygen isotopic composition, geochemist Hong Wang loads plantgenic carbonate samples into the Kiel Autocarb II device, which connects to the Finnigan 252 isotope ratio mass spectrometer, funded by the U.S. National Science Foundation. The device measures a microgram size of carbonate samples with high precision and accuracy, helping scientists to understand the details of the Earth's history.

During the past decade, the ISGS Radiocarbon Laboratory has participated in the program all four times and has received a perfect score each time. This record is an extraordinary accomplishment.

Radiocarbon Dating Lab

The laboratory's excellent reputation has led to a contract from the University of Tennessee-Knoxville to build a ^{14}C lab so that the university can date its own samples. Continuing its tradition of interagency cooperation and assistance, ISGS scientists readily agreed to the project. Because the University of Tennessee space is smaller than the Survey laboratory area, equipment design is being customized. Modern improvements are also being added.

The laboratory is being designed and tested at the Illinois Survey location. When finished, the lab will be disassembled and then reassembled and installed at Tennessee, where some final glassblowing will occur. ISGS staff will train the Tennessee staff on the system during fall 2001.

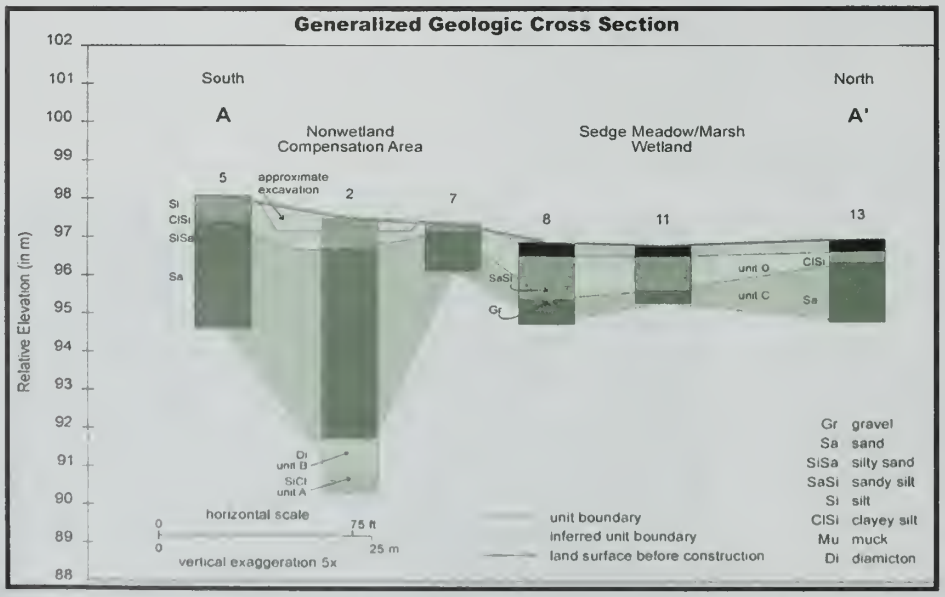
Shawn Schiffer, Mike Dodd, and Sallie Greenberg assemble the specially designed lab for University of Tennessee-Knoxville.

Van Patten Woods wetland creation site in 1994 before construction.

Van Patten Woods wetland creation site in 1996 after construction.

Wetlands

Hydrogeology, geomorphology, biology, botany, and pedology are all needed to investigate, assess, and monitor wetland areas. To obtain expertise in all of these areas, ISGS scientists work cooperatively with the Illinois Natural History Survey (INHS), Illinois State Water Survey (ISWS), Illinois Department of Transportation (IDOT), and Illinois Department of Natural Resources (IDNR).



A generalized cross section showing the unit boundaries and the geologic units of the non-wetland compensation area and the adjacent sedge meadow and marsh wetland.

IDOT Program

IDOT provides program funding to ISGS and INHS scientists to help IDOT meet the regulatory requirements for wetland creation, mitigation, and restoration as part of the state transportation construction program. The state realizes the importance of wetland areas: they help to purify run-off water, provide run-off buffers that mitigate urban flooding, and support diverse plant and animal life. If natural wetlands are damaged or destroyed through roadway construction, they must be restored or created elsewhere in the impacted drainage basin.

Peat mound (right) and adjacent wetlands after restoration, Hickory Grove compensation site.

ISGS hydrogeologists examine IDOT sites throughout the state for their potential as wetland compensation areas (or "banks") where wetlands can be created or restored. ISGS hydrogeologists are currently studying large (hundreds of acres) wetland bank sites in the Chicago Metro area, St. Louis Metro East area, Fayette County, and Illinois River floodplain sites in Grundy County near Morris and in Brown County near Meredosia. Some currently think these larger sites can provide a more sustainable environment for a wider variety of plant and animal species. Smaller (tens of acres) IDOT sites, however, have also met with success, as shown by the following examples.

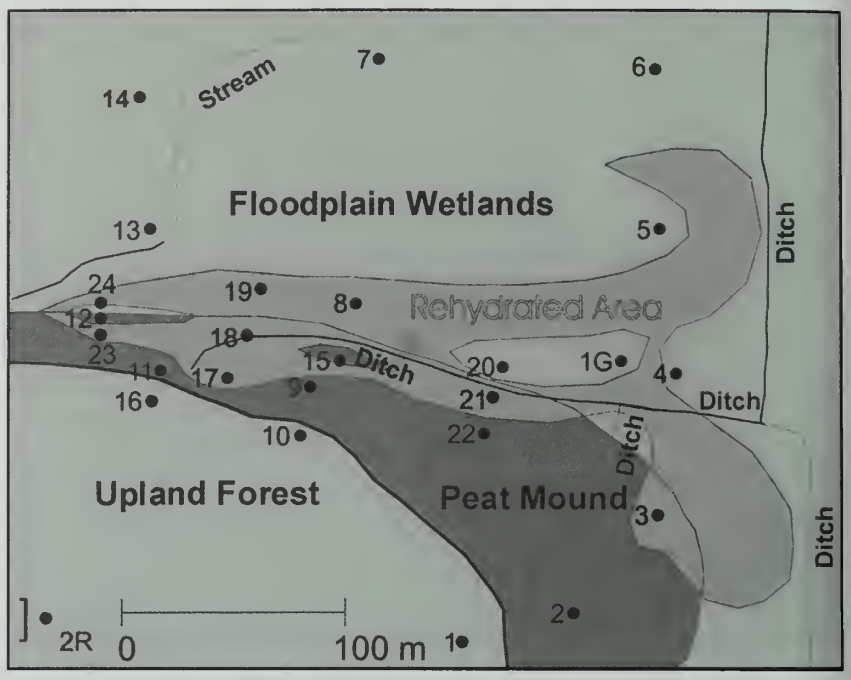
Van Patten Woods Forest Preserve, Lake County

The selected compensation site was adjacent to a sedge meadow and marsh wetland, which requires both a wet season and a drier season to function. ISGS hydrogeologists investigated the hydrology of the compensation site and compared it with the adjacent wetland. They evaluated differences between the sites and recommended shallow (50 cm) excavation to match the existing sedge meadow. Excavation resulted in an area where water fluctuates seasonally, mimicking the existing wetland and allowing the sedge to reproduce. Water-level data for the first five years after construction of the wetland in 1995 show that the entire excavated basin satisfies the wetland hydrology criteria of the U.S. Army Corps of Engineers.

Rehydrated portion of peat mound, Hickory Grove compensation site.

Hickory Grove Highlands Conservation District Site, McHenry County

In 1993, the McHenry County Conservation District offered a site for attempting fen-wetland restoration. ISGS and INHS scientists identified the drainage alterations—underground field tiles



Rehydrated areas of the fen-wetland complex, Hickory Grove compensation site. Numbers indicate the locations of monitoring wells.

and excavated ditches—that had drained part of the fen, the peat mound, and adjacent non-wetland areas. These drainage changes also allowed several encroaching woody species to invade and dominate the former wetland area. After IDOT and the McHenry County Conservation District removed the hydrologic alterations and the woody vegetation, portions of the site were replanted with native fen, wetland, and prairie plant species. Although some of the area does not meet the criteria for a wetland, recovery is expected to progress as groundwater flows are reestablished.

Small fringed gentian (*Gentianopsis procera*), which is native to wetland areas.

IDNR Program

The Nature Preserve Commission of IDNR funds a second ISGS wetland program, which was set up to assist the Nature Preserve staff in monitoring the effects of groundwater contamination or flow modification from surrounding land use or development on selected sites. The program also advises regional site staff on how to best maintain site hydrology to support preserve goals.

Lake in the Hills Fen Nature Preserve, McHenry County

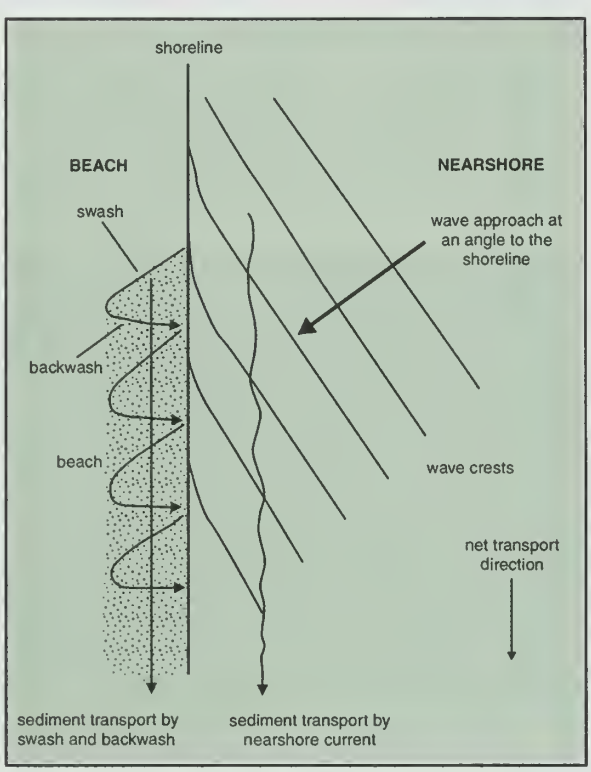
ISGS and ISWS hydrogeologists in this program worked together with IDNR staff to assess the potential threats to the preserve and to design an action agenda with the goal of minimizing short- and long-term groundwater impacts to the nature preserve. Gravel pit development adjacent to the preserve was thought to have changed groundwater discharge patterns and chemistry. Also, a municipal center was being planned for construction within the preserve's recharge area. Partially as a result of this assessment, IDNR purchased 70 acres of unmined land within a critical recharge area, pre-mining conditions near one fen are being restored, and the village of Lake in the Hills is seeking an alternate location for its municipal center.

Top: Looking out over Lake Michigan across the dunes. Left: ISGS field trip participants walk along the shore protection at Illinois Beach State Park.

Coastal Erosion

The ISGS Coastal Geology Section continues its programs of long-term monitoring of sand and bluff erosion along Lake Michigan's Illinois shoreline. Sand management at Illinois Beach State Park continues to be a priority project of the Department of Natural Resources. The Illinois Survey, working with DNR and the U.S. Army Corp of Engineers, Chicago District, are developing a long-term sand management plan. This plan should allow sand management to be preventive rather than just reactive to urgent needs. All involved agencies agree that beach nourishment is a better strategy currently than engineered structures. Part of the plan is to redistribute beach sand, taking sand from areas where sand is being deposited and supplying it to deficit areas. Beach stabilization through sand management will protect habitat and maintain a more natural appearance of this unique area.

A recent report to DNR described the improvements in coastal erosion management that have occurred since the 1970s. The Illinois efforts have stabilized the area to the extent that bluff erosion is no longer a relevant coastal management issue along the state's Lake Michigan shoreline. The efforts have largely eliminated problems that have long prevented Illinois from joining the Coastal Zone Management (CZM) program of the National Oceanic and Atmospheric Administration (NOAA). Illinois may now be able to enter that program.



Dynamic components that contribute to littoral transport of sediments. Sediment can be moved in either direction along the shore at different times, depending on the wave approach. However, one of the two directions has the net transport.

ISGS geologist, Dan Adomaitis, demonstrates the proper technique for conducting a magnetometer survey for buried metal objects. The presence of an underground storage tank is sometimes indicated by such a survey.

A scientist in the Environmental Site Assessment Section of the ISGS and an associate professor in the Landscape Architecture Department at the University of Illinois Urbana-Champaign (UIUC) together identified the need for a class where students would learn practical environmental site assessment (ESA) methods and techniques. The two teamed up to incorporate the discipline of ESA into a landscape architecture course on environmental impact statements, LA 450.

Two things make the course unique: (1) the immense amount of teamwork and coordination involved in its teaching and (2) its practical application to the outside world. For example, throughout the 2001 spring semester, a team of real-world specialists provided state-of-the-art information on ESA methods and techniques. Students benefitted from the contributions of eight ISGS scientists (seven from the ESA Section and one from the Wetlands Geology Section), one IDOT engineer, and staff at the UIUC Map and Geography Library.

Practical Training in Environmental Site Assessment

This class has provided opportunities to students as well as to the academic and professional community. One student found the course content so relevant that he secured an internship with the ISGS IDOT ESA program. The spring 2001 North Central Geological Society of America meeting featured a session on the development and innovative approach to teaching used in LA 450. The hope is to encourage others in the ESA field to pursue similar arrangements with their local colleges and universities.

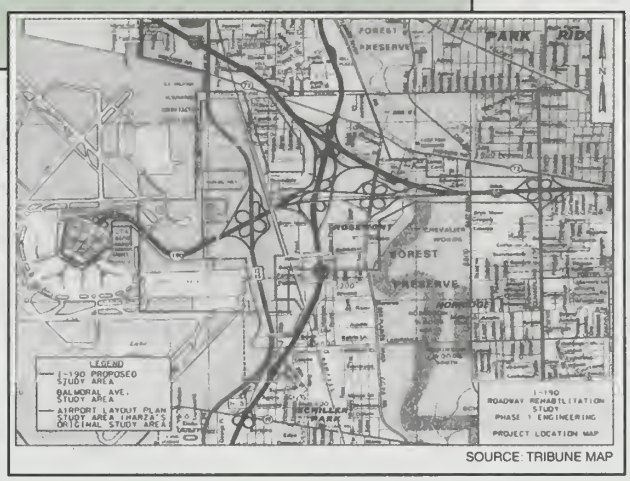
LA 450 student, Courtney Blood, records data as boreholes are drilled and soil samples are collected for the class project.

When a borehole is drilled and the presence of volatile organic compounds is indicated, equipment is decontaminated using an industry-standard cleaning solution. Here ISGS technician, Mark Hart, talks several LA 450 students through the process.

The O'Hare Corridor

A portion of the O'Hare corridor on I-190, which connects the City of Chicago with O'Hare International Airport.

To link the City of Chicago with the Chicago-O'Hare International Airport, the City of Chicago, in 1955, annexed roughly five miles of road, creating the controversial "O'Hare corridor." This corridor once again became a focal point of controversy in 1999 when the Illinois Department of Transportation (IDOT) proposed a major reconstruction of I-190, located within the corridor, to alleviate the ever-increasing demands by traffic to the airport. IDOT collaborated with the ISGS in developing a preliminary environmental site assessment of potentially hazardous sites along I-190, its various interchanges, and roads servicing the airport and the surrounding communities. The rapid and successful completion of the preliminary assessment was attributed to the cooperative relationships established with officials of the Illinois Tollway Authority, the City of Chicago and local municipalities, as well as the Chicago-O'Hare International Airport itself.



SOURCE: TRIBUNE MAP

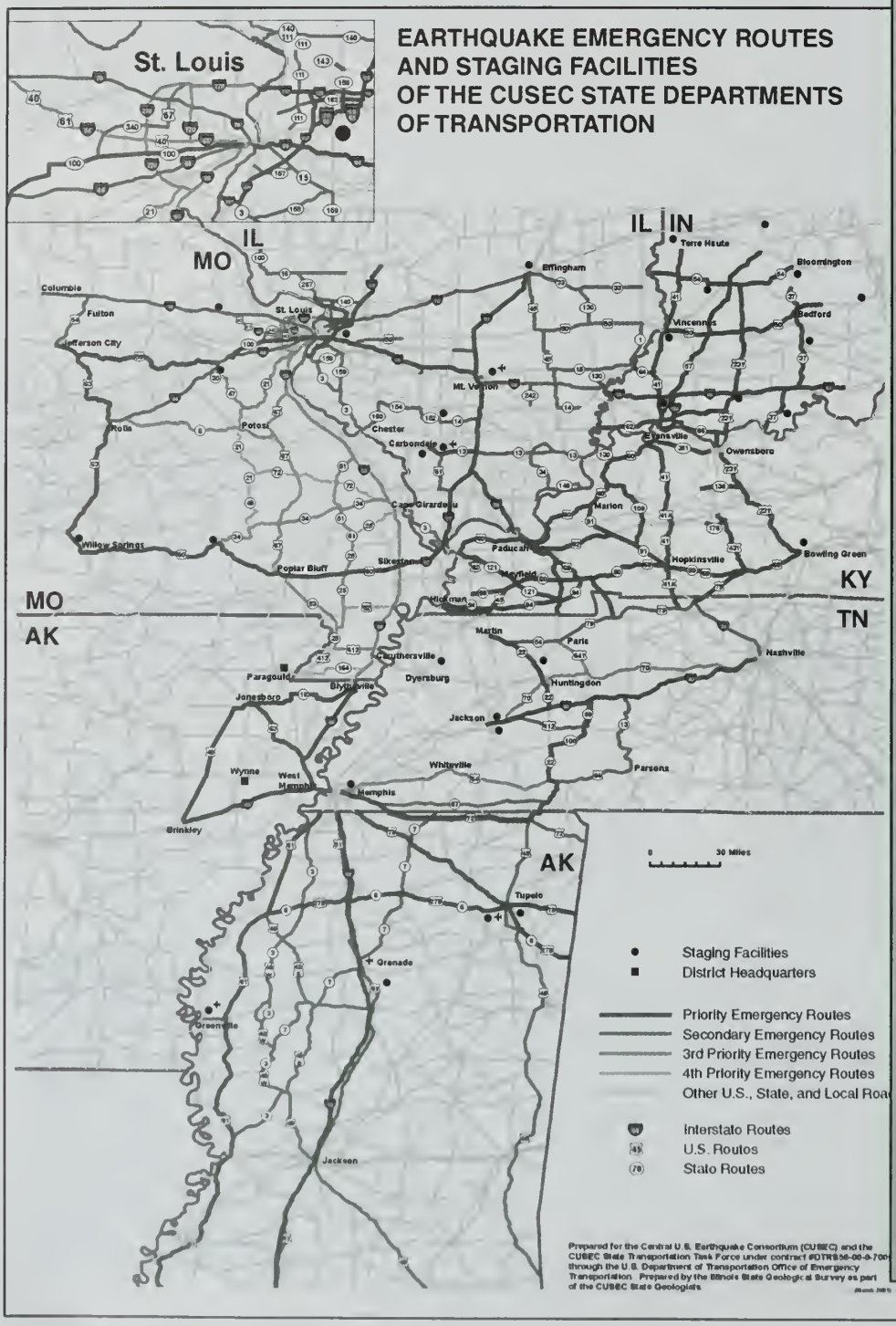
Map of the O'Hare corridor study area.

A view of a lake (top) and a forested path (right) in Jim Edgar/Panther Creek State Wildlife Area, before contamination.

Site M

In February 2001, a gasoline spill occurred at the Jim Edgar/Panther Creek State Wildlife Area (formerly known as Site M). Appropriate agencies responded quickly and cooperatively to the incident. The Illinois Department of Natural Resources, the Waste Management and Research Center Natural Resource Trustee Program, and the ISGS Environmental Site Assessments Section each utilized its own expertise in reporting about the incident, delineating the extent of the spill, and making recommendations to the Illinois Environmental Protection Agency (IEPA) as to how to handle the incident. The project is ongoing.

Earthquakes



CUSEC: Working Regionally to Plan for Geohazards

The Central United States Earthquake Consortium (CUSEC) state geologists have been working to compile earthquake emergency response highway routes for CUSEC's seven member states (Arkansas, Illinois, Indiana, Kentucky, Mississippi, Missouri, and Tennessee). Each state Department of Transportation has already developed its own earthquake emergency routes, and this new effort will combine this information to determine where emergency routes do not connect at state boundaries. This compilation is the first step in coordinating the extension of emergency routes across state lines for mutual aid in the event of an earthquake emergency. This regional map product is being produced for the CUSEC State Departments of Transportation Task Force.

Another part of this regional emergency plan is to select earthquake-resistant sites for staging facilities. These facilities will be used to coordinate emergency equipment and personnel by allowing experts to come together close to, but outside of, potential disaster areas.

As part of their goal to provide technically accurate, easily understandable geological information, CUSEC state geologists have produced soil amplification/liquefaction potential maps at a scale of 1:200,000 (1 inch = 32 miles) for the seven-state CUSEC area and at a scale of 1:250,000 (1 inch = 4 miles) for a large continuous area of the seven states that encompasses Belleville, Blytheville, Cincinnati, Dyersburg, Evansville, Memphis, Memphis Metro, Poplar Bluff, Rolla, St. Louis, and Vincennes. Geologists are now mapping at a scale of 1:24,000 (1 inch = 2,000 feet) for selected Federal Emergency Management Agency Project Impact communities in Illinois, Indiana, Missouri, Tennessee, and Kentucky.

Working Together to Support the Economy of Illinois

The economic strength and well-being of the state and its residents are advanced by the collaborative projects now in progress at the Illinois Survey. Partnerships with other state agencies and private companies have increased the effectiveness and relevance of ISGS research relating to public health and safety, resource mapping, energy production, and technological innovation.

Economic Resources

Health and Safety

ISGS geochemists are analyzing the sediments near important bodies of water, such as the Illinois River near Peoria and the Calumet River near Lake Michigan in Chicago. The history of the state's industrial and commercial development, nuclear fallout from above-ground testing, and other societal impacts is recorded in its lake and river sediments. Careful analysis of these sediments can thus provide information about what they contain and whether they can be cleaned, disposed of, or reused safely.

Present-day practices have environmental and economic impacts also. Waste from large animal facilities, for example, is being studied to determine whether waste handling and disposal practices pose a hazard to human health, and, if so, what practical measures can be instituted to avoid such hazards.

Resource Management

Ongoing mapping efforts, database development, and improved mineralogical analyses are providing Illinois planners and commercial ventures with the information they need to locate, develop, and find appropriate uses for the state's mineral resources. Stone, sand, and gravel are essential to build, repair, and expand the state's infrastructure. Illinois oil, gas, and coal keep homes, schools, and businesses operating—not only in Illinois, but in other states as well.

Innovation to Meet Challenges

ISGS geologists continue to seek new ways to make Illinois resources more economical to produce and more attractive to potential users. Whether producing new materials from waste by-products or developing more economical products and improved processes, ISGS researchers are in the forefront of technological development. Using coal fly ash to make commercial bricks, finding ways to use discarded coal fines, or using corn processing wastes to produce activated carbon are merely some of these innovations.

Rich Cahill and Josh Harris begin their examination of Vibra cores from Peoria Lake.

Peoria Lake Sediments

The ecology of Peoria Lake is threatened by excess sedimentation, which has made the lake very shallow in many areas. Dredging has been proposed to help restore the lake's vitality, but first the chemical composition of the sediments must be understood to ensure that they can be dredged safely. Sediments are cleaner today than in the past because of environmental regulations, so it is important to analyze both surface sediments and proposed dredged sediments to a depth of 6 feet.

Scientists from the ISGS Applied Geochemistry Section and two Illinois Environmental Protection Agency (IEPA)-approved contract laboratories recently analyzed sediment core samples from Peoria Lake for major, minor, and trace elements. Using a variety of techniques, the scientists analyzed samples that had been collected in 1998, 1999, and 2000; new Vibra core samples collected during fall 1998; and samples collected near river mile 165 in Peoria Lake, where dredging is being proposed. In general, the results for metals and most organic parameters were comparable among labs.

Metal concentrations in the Peoria Lake sediments were generally higher than background levels for Illinois soils. Pesticides, volatile organic compounds, semi-volatile organic compounds, and chlorinated pesticides were generally not detected. Results for polycyclic aromatic hydrocarbon (PAH) compounds varied, depending on the method used to detect them, and further research on those compounds is needed. Detailed, site-specific sampling and analysis will be required in areas proposed for dredging.

Even after dredging, land use and erosion control measures will be needed to prevent sedimentation problems from recurring. Geologic maps of the watersheds need to be developed in order to identify erosion-prone areas.

Peoria Lake at flood stage.

ISGS geologists head out on the highly polluted West Branch of the Grand Calumet River on a trip to collect sediment samples.

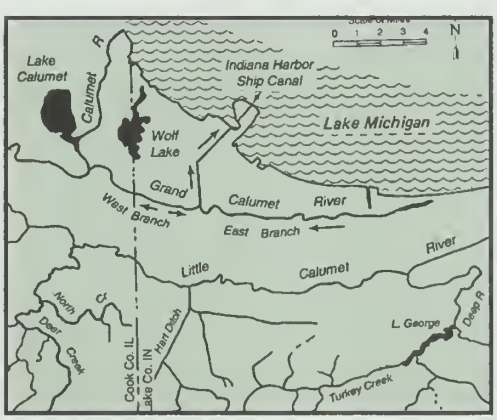
This seemingly idyllic portion of the West Branch lies just downstream of the outfall from Hammond's Sanitary District. Its sediments are among the most contaminated of the Grand Calumet River.

Sediments in the West Branch of the Grand Calumet River

Working jointly with the Illinois State Water Survey and with support from the Illinois Environmental Protection Agency (IEPA), ISGS geochemists continue their participation in a long-term study of the sediments and hydraulics of the West Branch of the Grand Calumet River. The study builds on the results of many previous studies in the area.

The West Branch is part of a highly polluted system of river channels and canals in the drainage network south of Lake Michigan. For more than a century, the system received massive amounts of industrial and sewage pollutants, and the highly polluted sediments continue to contaminate the water and surrounding environment. It is thought that many of the contaminants in the sediment in the West Branch of the Grand Calumet River were transported from the Indiana part of the river. Improper remediation of the Indiana portion could further disturb contaminated sediments, potentially releasing them—and the toxic compounds they contain—into the Illinois River system.

ISGS geochemists found that sediment core samples from the West Branch contained abnormally high concentrations of silver, arsenic, cadmium, chromium, copper, mercury, nickel, lead, antimony, tin, and zinc. Metal concentrations were greater than in previous samplings, but levels decreased downstream from the Illinois-Indiana state line and with depth. Mercury concentrations were very high. Concentrations of PAH compounds were extremely high; the sources of many of those compounds in the sediments are presently unknown. Only very low concentrations of PCB compounds were present. Pesticides were not detected.



Location of the West Branch of the Grand Calumet River in northern Indiana and Illinois.

Water quality analyses showed that nutrients, major anions, cations, and trace metals were all within the IEPA water quality standards but were greater than those in the Illinois River. Fine-grained sediments can be transported downstream, but storm or flooding events could deposit contaminated sediments on the surrounding floodplain. In fact, the U.S. EPA has identified the surrounding watersheds as "areas of probable concern." The study is ongoing.

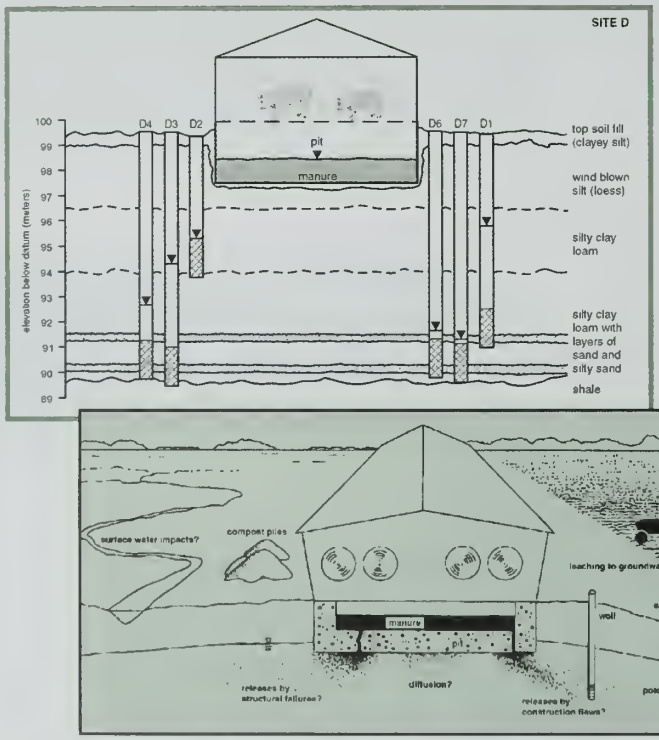
Pigs at rest.

Does the widespread use of antibiotics in animals affect antibiotic resistance in humans? If so, what are the routes of transmission? Can groundwater underneath and near animal facilities be contaminated by antibiotics? What about the soil? If contamination occurs, can it lead to gene resistance? Can animal confinement facilities be a source of enteric viruses entering the environment?

These questions and others are behind a multi-year study investigating the occurrence of antibiotics, bacteria, and viruses in groundwater near four hog waste facilities that use lagoons or deep pits for manure storage. The study is a joint effort between the ISGS geochemists and the University of Illinois Department of Animal Sciences researchers working with the Illinois Council on Food and Agricultural Research, U.S. Department of Agriculture, U.S. Geological Survey, University of Arizona, and cooperating commercial hog operations.

Antibiotics excreted in hog feces can be present in soil when manure has been spread on cropland as fertilizer. Monitoring studies have shown that inorganic constituents also can seep from waste lagoons into watershed systems and groundwater as far away as 100 meters downgradient. Groundwater contamination by organic compounds and pathogenic materials is of great potential concern since drinking water could be a direct route for the transmission of bacteria and antibiotic-resistant genes.

Antibiotics, Bacteria, and Viruses in Groundwater



Top: Location of monitoring wells surrounding Site D hog-rearing facility. Bottom: Potential sources of groundwater contamination.

Because the antibiotic tetracycline is widely used in hog-rearing operations, scientists are studying the occurrence and transfer of tetracycline resistance in bacteria in soil and in groundwater. However, detecting and quantifying antibiotics in environmental samples present unique challenges. Not only are some antibiotics present at very small concentrations, but other constituents in the sample can make detection difficult. As a result, scientists need to use a wide variety of analytical methods because procedures differ depending on which constituent is being studied.

Relatively new technologies can detect very small concentrations of antibiotics in environmental samples. Importantly, some of these technologies can identify and determine the antibiotic resistance of specific genes present in the environment, providing geologists with much more detailed information than was previously possible.

Preliminary results do *not* show the presence of enteric viruses in manure or groundwater. Many samples were either free of antibiotics or contained low concentrations. Most antibiotic detections occurred at a single facility where the groundwater is vulnerable to contamination. Some tetracycline-resistant bacteria identified in lagoons have also been found in groundwater. It appears that tetracycline resistance can be transferred to soil bacteria.

As more information becomes available, understanding the role of geology and hydrology in relation to the situations at waste lagoons and pits can help scientists suggest suitable ways to prevent or minimize the transmission of waste materials into groundwater.

Since its arrival at the University of Illinois in 1999, the portable infrared mineral analyzer (PIMA) has been put to good use in many of the Survey's programs. Used in combination with x-ray diffraction, PIMA analysis provides additional spectral details about the mineral contents of samples.

The user-friendly PIMA is portable enough for field use, and samples can be analyzed very quickly—about 100 samples in 3 or 4 hours. Data then can be easily transferred to a personal computer for further analyses and archiving.

The PIMA helps scientists identify the mineral contents of samples quickly, accurately, and without damage to the samples.

On the computer, reference mineral spectra can be overlain on sample spectra, if needed, to help with the identification. Another aid is the ability to use derivative spectra; that is, the PIMA can remove "background" material to clarify the important spectra. The PIMA not only identifies each mineral but also gives the percentage of each in the sample; these data are shown on a spreadsheet.

Once trained, even scientists who are not mineralogists can use the PIMA in the field and make quick analyses of mineral contents. Additional study by a mineralogist can refine the identification using x-ray diffraction; the trained eye of the mineralogist is likely to find subtleties and anomalies the non-mineralogist may have missed.

These are some of the PIMA's applications:

- *Oil and gas reservoir sandstones* The PIMA can penetrate deeper into the sample and can identify even very small amounts of minerals much better than x-ray diffraction. The unique properties—or "signatures"—of minerals can be amplified to improve identification.
- *Aggregate resources* Large numbers of samples can be analyzed to help create database standards. Properties of materials, such as asphalt superpavement, can be analyzed.
- *Environmental site assessment* Core samples, which can easily contain four to seven minerals, can be analyzed for mineral content and anomalies.
- *Geologic mapping* The PIMA is good for analyzing the mineral composition of soils, sediments, and glacial units. Analyses show contact points and anomalies.

Elements in Illinois Soil

ISGS geochemists are finding out more about the chemical composition of Illinois soils. Gathering baseline soil information is becoming increasingly important as people come to realize that soils not only provide essential nutrients to plants, they also can contain contaminants and elements that can possibly affect human and animal health.

The research on elements is part of a comprehensive, long-term study, which began in 1998, to survey the soils of the entire state. Soils are being sampled in square grids, with nodes spaced twenty miles apart, and stratified according to soil types.

The study is helping geochemists

- **understand more about the element composition and chemical properties of soils,**
- **understand the variation in soil composition throughout the state, and**
- **identify soils that have an excess or a deficiency of selected trace metals.**

ISGS scientists collected 180 samples from 90 sites in 58 counties to obtain data for forty major, minor, and trace elements in surface and subsurface soils. These data are providing valuable information about the regional distribution of these elements in Illinois soils. Elements were found to be influenced by the parent soil material, soil formation processes, and the way in which the elements themselves move and partition in soil environments.

Chemical analyses showed that lead was the only heavy metal found in potentially elevated concentrations, indicating some contamination of some Chicago area sites. No other trace metals were present in excess. Concentrations of boron, copper, cobalt, and zinc were lower than baseline values in several areas of the state.

Mineralogist Dewey Moore with a set of samples to be analyzed for mineral content by x-ray diffraction.

Findings by ISGS geologists and University of Illinois archeologists have overturned some long-standing archeological assumptions about prehistoric North America. Mineralogical analyses of pipestone samples using recently available methods have provided startling information that helps correct the identification of artifacts and the understanding modern scientists have of prehistoric peoples.

Cahokia

The Cahokia mound builders in southeastern Illinois were thought to have traded extensively with distant cultures to the north; this presumption was based on samples of red stone artifacts.

Recent mineral analyses using x-ray diffraction (XRD) and spectroscopic analysis, however, showed that most of the red stone fragments found in Cahokia are a local Missouri red flint clay, not the rare catlinite stone that originates in Minnesota. The tests also showed that the catlinite artifacts found in Cahokia arrived much later, during the sixteenth and seventeenth centuries.

Pipestone Provides Proof

Until recently, archeologists have not been able to distinguish between visually similar red siltstones, pipestones, and catlinite and had mistakenly identified many specimens as catlinite. One problem with analyzing fired-clay materials by XRD analyses is that the firing process breaks down the clay mineral and destroys its XRD "signature." New methods in mineralogical studies using the portable infrared mineral analyzer (or PIMA) allow scientists to differentiate the minerals in stones that appear to be similar. For example, catlinite is distinctive because it doesn't contain quartz. PIMA is especially valuable because it is portable enough to be used in the field, and it allows analyses without destroying the samples, a concern with rare and archeological specimens.

The mineral "signature" of this excellent example of Illinois pipestone provides clues about its origin.

Sterling

Near Sterling, Illinois, University of Illinois archeologists working with the Illinois Department of Transportation uncovered pipestone artifacts as well as pipestone material that traditionally had been thought to have come from Ohio. When ISGS geologists were asked to analyze the samples by x-ray diffraction, the distinctive patterns of clay mineral crystals helped scientists identify individual minerals.

Randy Hughes (right), ISGS mineralogist, discusses the characteristics of a platform pipe excavated from the Sterling-Rock Falls area with University archaeologist, Tom Berres (left).

ISGS researchers found that Sterling pipestone contained berthierine, which has only been found in Illinois and outside North America. This discovery provided evidence that the pipestone came from the Sterling area, not Ohio. Mineralogical analyses of other materials can help archeologists better understand prehistoric societies.

Geologists working with berthierine also concluded that this mineral might be associated with petroleum reservoirs. Further study, at Sterling, of the Neda Formation that contains the pipestone may yield valuable information about the potential for recovery of water and mineral resources.

ISGS geologists are mapping stone resources in the rapidly urbanizing St. Louis Metro East area of Illinois. Locating and characterizing stone resources in Madison, St. Clair, Monroe, and Randolph Counties before they are covered up by development is important to planners, agriculture, and industry in the region.

Aggregate Resources

Thick deposits of high-quality stone, sand, and gravel—especially those that are near enough to the surface to be mined economically—are not available everywhere, yet large quantities of these materials are essential to support many human activities, including urbanization and continued growth. Because the materials are very heavy and costly to haul, they must be located near where they are used, or they quickly become quite expensive.

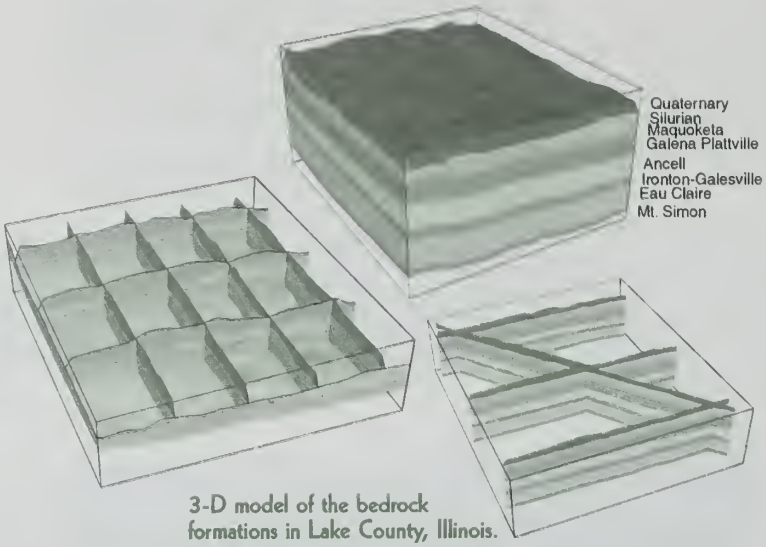
Information from oil, water, and mineral test wells and from quarry cross sections and cores is being used to map changes in rock units. The thickness, depth, and quality of the deposits are evaluated to determine their economic potential. For example, limestone of a quality appropriate for its potential use is especially valuable.

Aggregates are important to the state's agriculture and industry. For example, limestone and dolomite are used in agriculture to help control soil pH. High-purity limestone is needed for scrubbers at coal-fired power plants to remove sulfur dioxide from flue gases. Quartz sand is used for glass-making and as a component in other industrial processes. Railroad beds use crushed dolomite as ballast.

The largest use of aggregates, though, is building and maintaining the state's infrastructure: the construction and maintenance of roads, bridges, and buildings. Governor Ryan's Illinois FIRST program to support the repair of the state's roads and bridges should increase the need for construction materials over the next five years.

Knowing the location of stone resources can help reduce exploration costs and help environmentally responsible development of mines and quarries. Mapping stone resources, especially limestone, will help to ensure that adequate supplies of aggregates will be available to meet the area's needs for them.

Extracting limestone from the Alby Quarry near Alton, Illinois.



3-D model of the bedrock formations in Lake County, Illinois.

Mapping Lake County Bedrock

A team of ISGS geologists has developed a set of maps, cross sections, and 3-D models of the bedrock formations in Lake County, Illinois. The set includes structure and thickness maps for key rock units from Silurian dolomite at the bedrock surface down to the Mt. Simon Sandstone, resting on granite at a depth of approximately 3,500 feet.

These bedrock formations form important aquifers for both residential and municipal water wells in the county and are a primary source of construction aggregate in northeastern Illinois. The information gained by bedrock mapping will be useful in planning new residential and industrial developments, in making resource assessments, and for major underground construction projects.

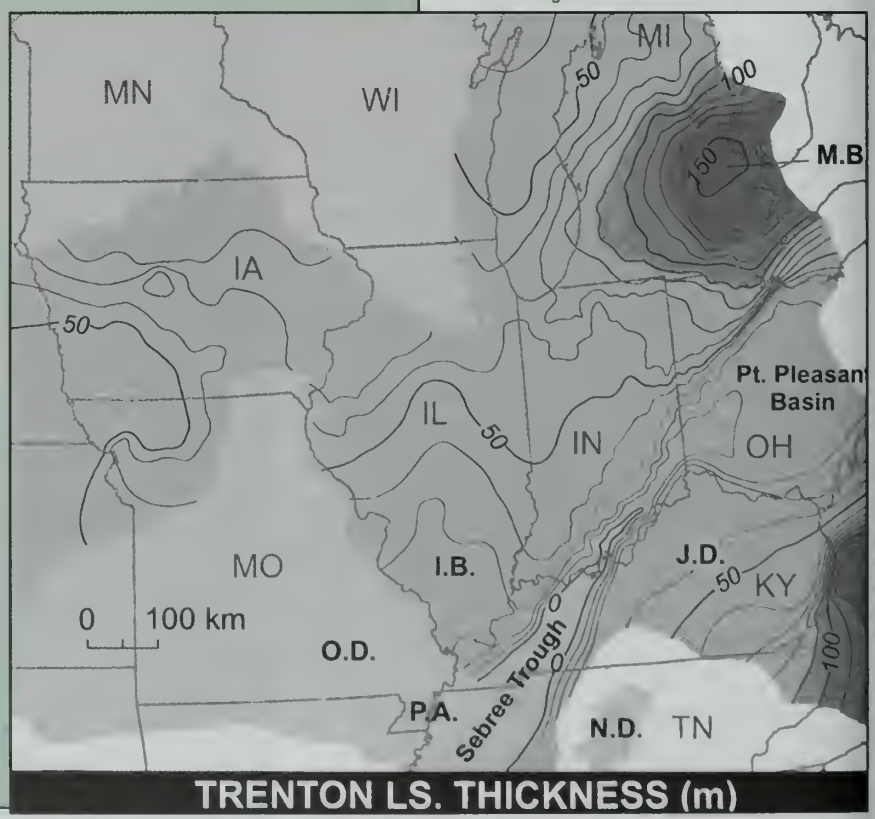
Oceanic Passage to the Midcontinent United States—The Middle Ordovician Sebree Trough

Models of ancient environments of deposition can be used to suggest where resources such as coal, oil and gas, and industrial minerals and metals might be located. Recently, ISGS geologists developed a model of the Middle Ordovician Galena Group, a limestone and dolomite unit that contains both aggregates and petroleum. This important unit underlies most of Illinois.

The model shows that these rocks were deposited on a shallow marine platform in a tropical environment. The southern edge of the platform, situated in western Kentucky and Tennessee, was bordered by a relatively deep water trough—the Sebree Trough—that connected to an oceanic basin along the southern margin of the continent. The cool, oxygen-poor, phosphate-rich oceanic waters in the trough had a major influence on the distribution, thickness, and composition of the Galena carbonate rocks.

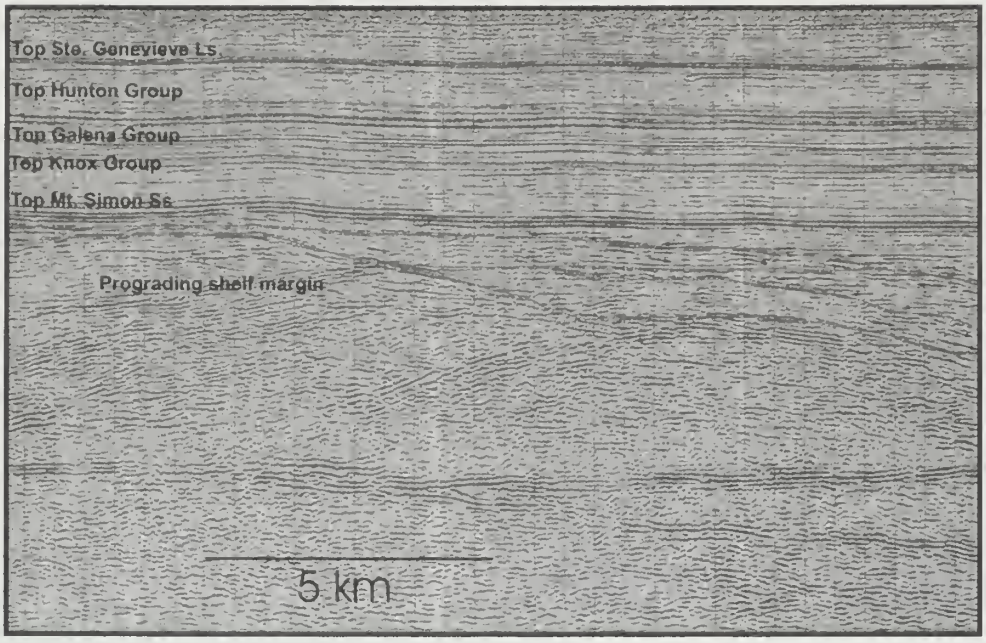
The new model can help geologists predict the likely occurrence of rocks containing petroleum and carbonate facies in the midcontinent. The model is featured in the August 2001 issue of the *Geological Society of America Bulletin*.

Map shows the thickness (in meters) of the Trenton Limestone in the area adjacent to the Sebree Trough.



Geophysicists are using old oil company seismic reflection profiles to form exciting, newly available images of the Earth's crust and uppermost mantle beneath the Illinois Basin. The images have been derived by re-analyzing several hundred miles of industry seismic reflection recordings.

Researchers at the ISGS have applied the "seismic stratigraphy" technique used in the petroleum industry. This interpretive technique is being used to test the idea that some of these images may represent sedimentary rocks capable of hosting valuable oil or gas.



Seismic image provides a cross section view of the layers of rock formations beneath the Earth's surface. These images may provide an additional way to gather information useful for locating oil and gas.

Exploring the Earth's Crust Beneath the Prairies of Illinois

The newly available records, which provide cross sections looking as deep as about 45 miles beneath the surface of south-central Illinois, show three highly coherent stratigraphic sequences beneath the part of the Illinois Basin that has traditionally been explored for petroleum. The shallowest of these may contain new targets for future deep petroleum exploration.

MIDCARB

A new, multi-year regional study will gather data to determine whether the CO_2 being produced by power plants and other industry can be effectively sequestered underground instead of being released into the atmosphere.

In the first year of data gathering, scientists are seeking information that will help them

- **understand the economic impact and value of CO_2 recovery and sequestration;**
- **analyze the quality, size, location, and geologic integrity of potential sequestration sites;**
- **evaluate the costs to move the CO_2 from its source to a storage site;**
- **assess the usefulness of the potential technologies.**

From these data, ISGS geologists—in cooperation with natural resource organizations in Indiana, Kansas, Kentucky, and Ohio—want to produce the Midcontinent Interactive Digital Carbon Atlas and Relational Database (MIDCARB). Once developed, MIDCARB will provide private and public decision makers with around-the-clock access to online information, digital databases, current scientific and policy studies, and geographic locations of CO_2 sources and potential CO_2 sinks.

The MIDCARB study group has already developed objectives, proposed methods and protocols, and established the kinds of data that will be gathered and the geographic information system (GIS) software that will be used to accomplish the interactive mapping. This approach promises to provide geologists with in-depth knowledge about regional geology and allows geologists to share perspectives, expertise, and technology as the project moves forward.

The project has great immediate and long-term benefits for Illinois by providing the geologists the opportunity and the means to do additional mapping. Geologists already know that the Paleozoic units of Illinois provide some ideal settings for gas storage—the state is already a major underground storage area for natural gas. Additional mapping will provide detailed information about the Mt. Simon and Cypress Sandstones, two of the most permeable, most porous siliciclastic formations in the state. Existing well records will be digitized to provide information about the depths to these formations. Because these formations are generally found at depths below the freshwater zones, geologists think that our state's fresh groundwater resources should not be affected by CO_2 storage. Only saline aquifers will be investigated. Freshwater aquifers will not be considered as sites for CO_2 injection.

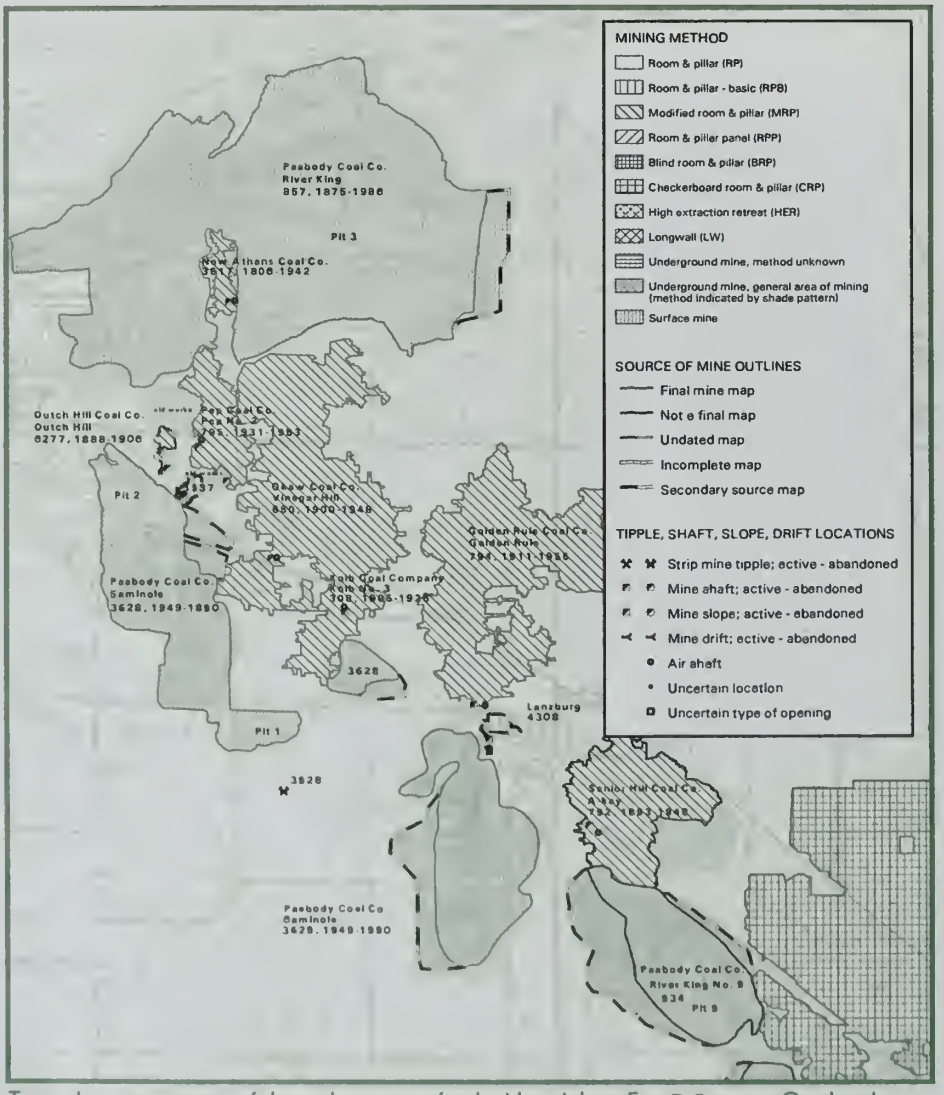
Coal Mine Maps

Because of the state's vast coal resources and the historical importance of coal to the Illinois economy, many people are interested in knowing the location and status of underground and surface mines. County and municipal planners, road and bridge construction project engineers, individual homeowners, and historians are some of those who use mine information.

The ISGS Coal Section is currently improving the quality and amount of mine information available by producing detailed (1:24,000) 7.5-minute quadrangle mine maps. The Illinois Department of Transportation and the Illinois Mine Subsidence Insurance Fund are providing support for this mapping project, now in its second year. So far about fourteen maps have been produced for the St. Louis Metro East area in St. Clair and Madison Counties. More mapping is being planned for Macoupin, Marshall, and Franklin Counties.

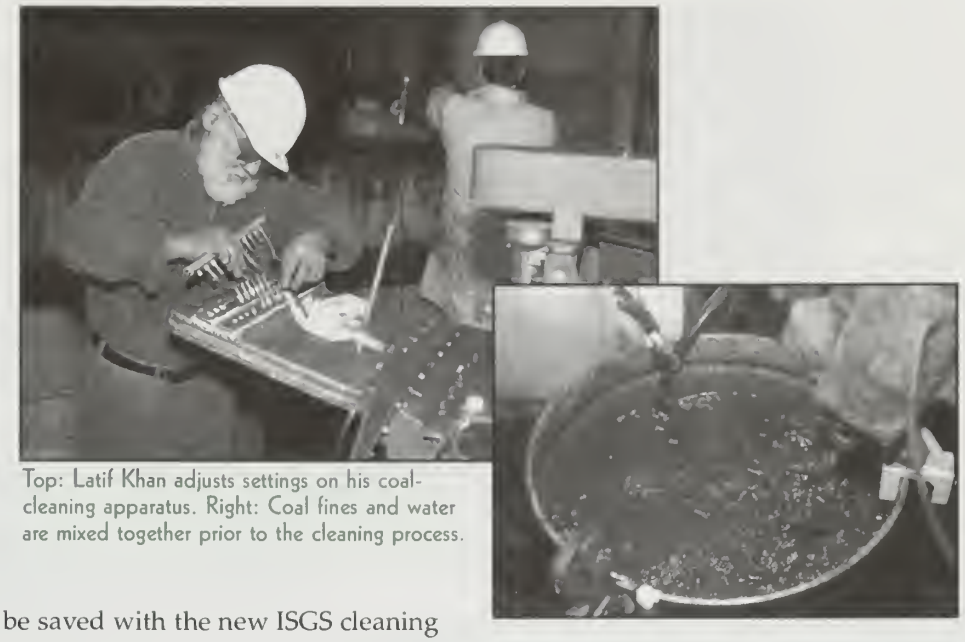
The maps show the location of coal mines on a topographic map base for user ease of reference. Mines are identified by index number, name, and years of operation. Mining method and the location of escape and air shafts are given, when known. Engineers can use this information to determine potential subsidence patterns and either avoid building over these areas or take steps to fill or stabilize the areas ahead of construction.

Each map comes with a directory that provides more complete information about the mines and indicates the type of source maps and their availability. The new coal mine maps are available free for download from the ISGS Web site (http://www.isgs.uiuc.edu/) or may be purchased as paper copies from the ISGS Information Office.



Two-color representation of the coal mine map for the New Athens East 7.5-minute Quadrangle.

With the continued financial support of the Illinois Department of Commerce and Community Affairs, ISGS researchers in the Applied Research Lab have developed the technology to wash fine coal and have been testing it on a commercial scale this year. Coal companies are interested in this technology, which promises to increase the efficiency and profitability of operations using Illinois coal.



Top: Latif Khan adjusts settings on his coal-cleaning apparatus. Right: Coal fines and water are mixed together prior to the cleaning process.

Previously, coal companies have not been able to burn very fine coal, called "fines," and had to dispose of it, mostly in tailing ponds. The coal production loss and the cost of waste disposal can be saved with the new ISGS cleaning method. In addition, the apparatus used to clean the coal is relatively inexpensive to manufacture.

The technology, which has already proved quite successful in the laboratory and on a pilot scale, takes very fine coal, cleans sulfur and contaminants from it efficiently with one wash and produces a high-quality product that can be burned without further cleaning. A patent for the improved washing process is being sought.

Using Coal Fines

ISGS organic chemist and principal investigator Mei-In (Melissa) Chou, displays samples of fired bricks made using fly ash, a by-product of coal combustion.

Making Bricks Using Coal Fly Ash

A new brick manufacturing method using coal combustion waste may soon benefit the Illinois coal industry, the brick industry, and Illinois utilities using coal. Research scientists at the ISGS have completed studies on the technical feasibility of producing fired bricks containing high volumes of Illinois class F fly ash. Preliminary economic studies have been conducted.

Three million tons of fly ash, a by-product of coal combustion, is produced in Illinois each year, most of which is discarded in tailings ponds. The demand for fired bricks, meanwhile, is increasing each year. Finding a way to produce high-quality bricks using fly ash could save brick manufacturers up to 70% of their total cost for raw materials. Utilities will decrease their landfill costs for solid waste disposal. A cheaper way to burn Illinois coal would definitely help to improve the marketability of Illinois coal.

The test bricks containing Illinois fly ash met all commercial specifications. They had better color and physical consistency, lighter weight, greater compressive strength, and lower thermal conductivity than standard bricks. Thus, bricks made with fly ash can be easier to transport and insulate better. ISGS scientists are now working with brick companies to scale up production and commercialize the new technology.

ISGS scientists, Vinod Patel and Mei-In Chou, stand with plant supervisor, Jim Falter (center). Green bricks from a medium-scale pilot-plant production at J.C. Steel & Son are ready for firing at Global Clay Marseilles.

Drilling records for this oil well a few hundred feet from the methane coring site provided accurate information about the approximate depth of coal beds to be tested.

As gas prices have increased in recent years and conventional reserves of natural gas have declined, a great deal of interest is being generated in the potential of Illinois coal beds to yield methane gas. With 200 billion tons of coal resources, Illinois has the potential to yield important stores of methane from its thick and extensive coal seams. The project should also improve the understanding of the state's coal resource availability and economic potential.

Measuring Methane in Illinois Coal

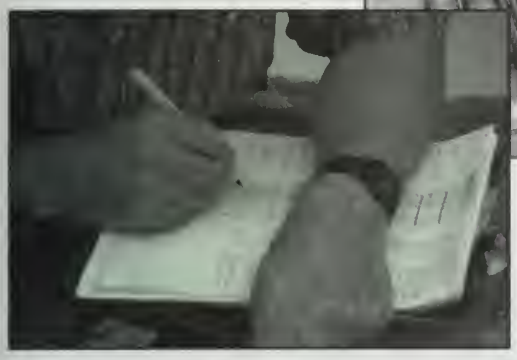
Coal-bed methane extraction attempts in the western United States have shown that, to be successful, many factors (local gas content, cleat development, coal quality, water production and quality) must be understood before commercial extraction begins.

With these considerations in mind, ISGS geologists in the Coal and the Oil and Gas Sections are adding information to the existing ISGS database with a new project, now in its first year, and supported by the Office of Coal Development and Marketing. The geologists are proceeding

- to delineate the total coal thickness in Illinois;
- to obtain data about gas desorption of all major coals in the north, west, central, east, and south parts of the Illinois coal field;
- to determine the composition and origin of coal gas in Illinois;
- to determine the characteristics of the newly sampled coal that affect available methane;
- to produce digital maps that rank Illinois coal field areas for their potential to produce methane economically.

Geologists hope that coal-bed methane can generate income even from coal beds that are too thin or too deep to be mined, since the coal can remain in place. In some areas, multiple, vertically stacked coal seams may be able to be tapped at the same time. Also, for seams with mining potential, mining safety may be improved if the gas is removed before coal mining begins.

A drill operator (left) hoists a 10-foot length of pipe toward the drill hole; a tool will be sent down the hole to grab core. A second member of the drill crew (right) works to remove the 200 to 300 pounds of rock just retrieved.



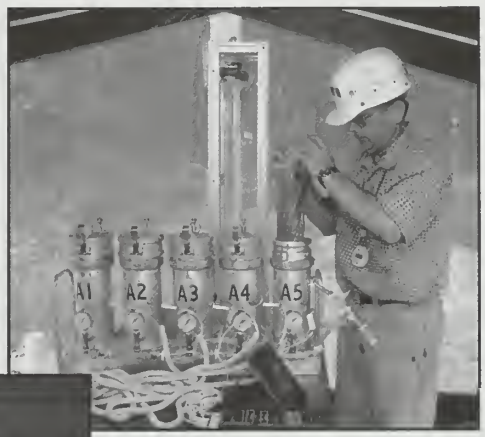
Right: Dave Morse and Curt Blakley, from the ISGS Oil and Gas Section, examine just-boxed core samples. Below: Using the core samples as a reference, Dave Morse records the depth at which formations occur and generates a stratigraphic column from the data.

Illinois already has an extensive network of gas pipelines that can be used to move gas to potential markets. Coal-bed methane should benefit coal owners, coal companies, oil and gas operators, and county economies. Because of the commercial potential for coal-bed methane extraction, ISGS geologists are working in partnership with private companies.

To obtain samples, a coring drill rig is used to penetrate the underlying coal seams. Depending on which part of the state the geologists are working in, drilling depth ranges from 500 to 1,500 feet. Wells are drilled using water pumping and wireline retrieval to minimize gas loss from the cores. Data from the geophysical logs of the well bores will be used to support core data about the thickness, density, stratigraphic position, and roof rock of the coal beds.

When possible, two samples are taken from each coal seam for gas and other analyses. Coal cores are removed from core barrels quickly, cut to 12-inch lengths, and sealed in airtight canisters. The volume of gas released from the samples is carefully measured at timed intervals. After these desorption tests are completed, coal cores are removed from the canisters and crushed in a sealed ball mill to measure residual gas. The released gas that has been collected is then sampled for chemical and isotopic analyses to determine its quality and origin.

The project should improve the understanding of availability of coal-bed methane and its commercial potential in Illinois.



Above: Ilham Demir, ISGS geologist in the Coal Section, demonstrates the placement of coal core samples in the desorption unit. The samples are placed under heat close to the conditions they originated in. Pressure is gradually reduced to extract the methane desorbed from the coal. Below: Ilham Demir (right) describes for Rob Finley (left) how the released methane gas will enter the glass columns and will be measured.

Coal delivery outside of Abbott Power Plant on the University of Illinois Urbana-Champaign campus. The plant's high-quality scrubbers posed a challenge to ISGS researchers who had to find ways to test the flue gases before they reached the scrubbers.

Mercury Sorbents

Researchers in the ISGS Applied Laboratory, in cooperation with the University of Illinois, Apogee Scientific, and URS Radian, continue their multi-year study of mercury sorbents. The collaborators are testing corn-based activated carbons for their effectiveness in removing mercury from coal combustion flue gases.

ISGS engineering geologist, Massoud Rostam-Abadi (left), and technical assistant, Jimmie Cooper, discuss the progress of the on-site installation of modified and specialized equipment needed to test the carbon-injection technology.

A sorbent that is less expensive or more effective than existing commercial sorbents would be of great benefit to Illinois coal companies and coal-fired power plants. Project supporters include the Electric Power Research Institute, Illinois Clean Coal Institute, Illinois Office of Solid Waste Research, and Illinois Corn Marketing Board.

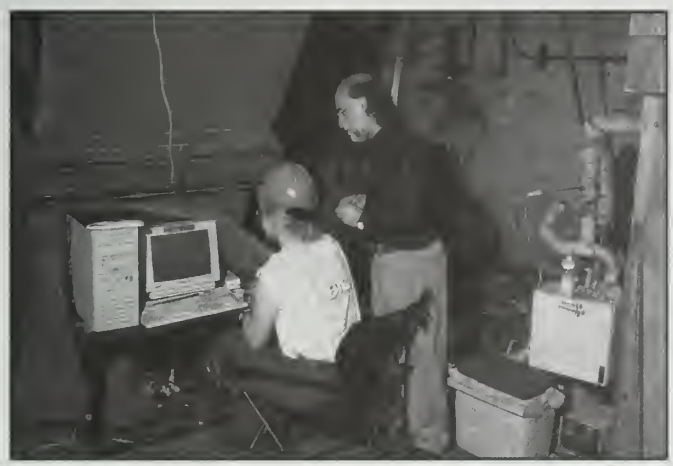
Apogee engineers (right) point out to principal investigator, Massoud Rostam-Abadi, the completed modifications needed to allow the commercial testing of corn-based mercury sorbents at Abbott Power Plant.

The corn-based activated carbons, developed by ISGS chemical engineers, have already proved to be inexpensive and highly effective in removing both elemental mercury and mercuric chloride from coal combustion gases in laboratory and pilot-scale tests. Commercial-scale tests to remove this very toxic, soon-to be regulated pollutant from coal flue gases are now underway. Because the adsorbent particles are in contact with the flue gases for just a few seconds, the carbon needs to be very reactive.

A group of interested visiting scientists listen as an Apogee engineer (second from right) explains the custom-made equipment especially designed to monitor and test the effectiveness of the corn-based activated carbon in removing harmful mercury from coal flue gases. ISGS scientists Massoud Rostam-Abadi (third from left) and Scott Chen (far right) are available to answer questions and describe processes.

Commercial-scale testing has unique challenges. Combustion conditions and equipment are not always ideal or as controlled as they are in the lab. Equipment, technology, temperature, and coal composition are just some of the variables that have to be considered.

The initial large-scale test, at Abbott Power Plant on the University of Illinois campus, required extensive modifications to allow the injection of carbon ahead of the highly effective filtering system in place at the power plant. Equipment and instruments were designed by the commercial partners specifically for the conditions at the power plant so that test processes and results could be measured accurately and completely.



Massoud Rostam-Abadi and an Apogee engineer monitor the carbon-injection process.

Results from this test were very successful, and the cost of making the corn-based, activated carbon at a commercial scale is being evaluated.

Delivering geologic information to the public is an essential part of the Illinois Survey's mission. Whether the information is transferred to the public through databases, map products, publications, workshops, or public events, the purpose is the same: to provide the people of Illinois with up-to-date, complete, and objective geologic information in the most understandable and usable formats.

Recent technological advances have increased the scope of projects and the abilities of ISGS staff to disseminate information. At every step, though, it is dedicated staff who make the difference—in interpreting information, ensuring its accuracy, and communicating the information in the best way possible.

Information Delivery

Online Access

Data gathered from historical records, field work, and scientific experiments and analyses must be first assembled, interpreted and sorted, and archived. As data are entered into electronic forms, ISGS staff work hard to consider the information's many potential applications, its likely users, and the most effective ways to disseminate the information.

Large electronic databases, available online through the World Wide Web, allow digitized data to be widely accessible to the interested public. To consolidate historical records, make their format more consistent, and improve access to them, paper and electronic records are being transferred to digital databases. Current efforts include digitizing information about existing pipelines, wells, mines, and aerial photographs. Providing more detailed information on a statewide basis through digital orthophotographs and digital elevation models has also become a reality this year.

As more and more information goes online, ISGS staff seek additional and better ways to ensure user access—by improved Web page design and organization, by providing user instruction where necessary, and by testing distribution methods.

Publishing

Technological advances have also streamlined the print publication of maps, reports, and other print products, allowing information that exists in a variety of formats to be brought into electronic files for editing, design, and printing. This material can also be easily transferred for use on the Internet or in CD-ROM or videotaped products. Digital archives of photographs and videotaped footage are being assembled to document the projects, methods, and equipment of ISGS geologists. Cost-efficient, multimedia presentations and products should increase the effectiveness of educational, informational, and outreach efforts.

Outreach

In a "low tech," yet highly effective program, educational outreach efforts allow ISGS geologists the chance to interact directly with the public in an individualized, personal way. Each year, the highly popular ISGS field trips to interesting locations in Illinois provide a way for about 600 individuals to learn about the state's geology. Successful workshop programs—Near and Far Sciences in Illinois, ENTICE, and GeoExplorer—target the state's teachers. Teaching teachers about geology and its importance is an efficient way to transfer information to tomorrow's decision makers and informed citizenry. The enthusiasm teachers have shown for these programs and the response their students have shown to the classroom activities prove how effective teacher training can be.

In addition to these formal programs, ISGS geologists individually participate in public events at various locations across the state: staffing the ISGS exhibit at the Illinois State Fair and Dinofest in Chicago; preparing lectures, coursework, and demonstrations of techniques and equipment for university students; instructing 4-H, Boy Scouts, and other organized groups in geology; making presentations for secondary and elementary science fairs and events; and participating in nature programs and rock and mineral shows.

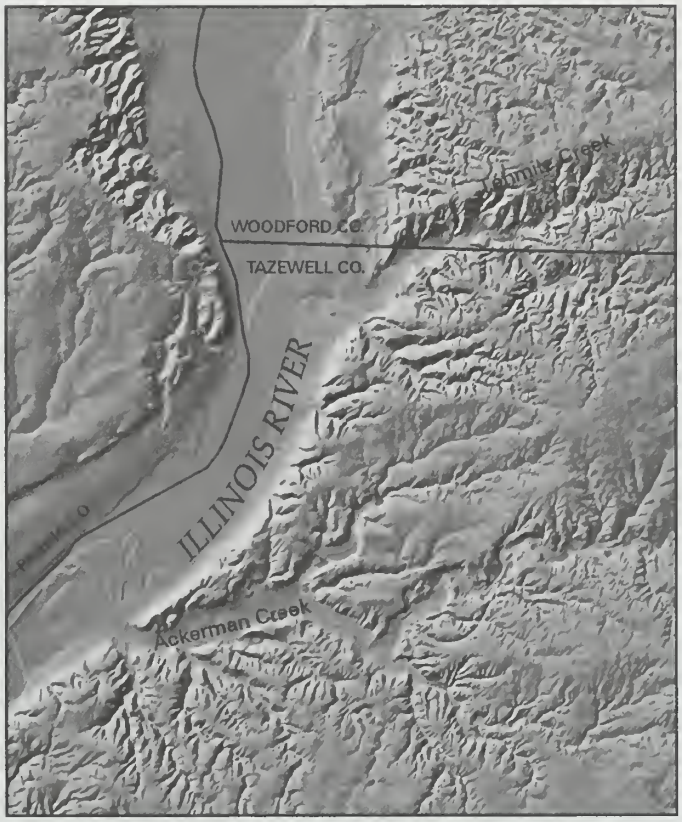
During the past year, ISGS scientists have compiled a statewide mosaic of digital elevation data for Illinois. To create the mosaic, 1,106 U.S. Geological Survey, 30-meter × 30-meter resolution digital elevation model (DEM) files have been processed. The result is the most detailed depiction of the surface of the state currently possible.

Traditional topographic quadrangle maps represent elevations using contour lines, but DEMs are a more effective visual representation of the elevation data. DEMs—data files containing terrain elevations for ground positions at regularly spaced horizontal intervals—have been used in conjunction with specialized algorithms to produce a shaded relief map of the state that shows elevation information as dramatic visualizations of the surface topography.

Surface Topography of Illinois

The *Surface Topography of Illinois* will be presented in full color so that actual elevation ranges can be directly interpreted. The current plans are to publish the map at a scale of 1:500,000 (1 inch equals 8 miles) as well as a print-on-demand poster map (1:350,000, or 1 inch equals 5.5 miles). A digital version of both the original elevation mosaic and the *Surface Topography of Illinois* will also be made available to the public.

For many years to come, the *Surface Topography of Illinois* map and its associated database should be a valuable tool for a variety of users, including geologists, hydrologists, watershed and regional planners, and anyone interested in getting a better understanding of Illinois' diverse surface landforms.



A portion of the surface topography map reproduced in black-and-white at a map scale of approximately 1:158,400 (1 inch equals 2.5 miles). The area portrayed is Peoria, Illinois, and environs. The elevation information is processed such that the terrain aspect and slope appear to be illuminated from the northwest at a sun angle of 40 degrees above the horizon. Because the surface of Illinois is relatively flat, the DEM data are vertically exaggerated by a factor of 6 to 8 to provide more definition to subtle landform variations.

The ISGS is digitally compiling information about the gas and oil transmission and distribution pipelines that traverse the state as part of the national pipeline network.

National Pipeline Mapping System

The ISGS has been asked to play a crucial role in providing information about the location and capacity of Illinois' transmission and distribution pipeline system. This information is needed to monitor the national pipeline system that is currently in place to move oil and natural gas nationwide.

Illinois' annual petroleum-refining production far exceeds its total consumption of petroleum-based products. Transmission pipelines carry crude oil both from within and outside the state to one of the state's seven active refineries. Pipelines also carry the refined products—including gasoline, heating oil, jet fuel, kerosene, diesel, and ethane—to Illinois consumers and to the rest of the nation. Natural gas transmission pipelines are used to move natural gas from the Gulf Coast and the West to underground storage fields and above-ground natural gas facilities in Illinois. An extensive pipeline distribution network then moves the gas to consumers.

The ISGS has been designated as the state repository for pipeline data in Illinois in support of the U.S. Department of Transportation, Office of Pipeline Safety's newly created national pipeline mapping system (NPMS).

The goal of the project is the digital compilation of current pipeline information. ISGS will collect, automate, convert, process, maintain, and disseminate digital petroleum and liquified natural gas pipeline data for Illinois and submit the digital databases to the NPMS.

The ISGS is a logical choice to serve as the state repository because of its extensive experience with the oil and gas-producing industry, because it is the primary digital mapping agency in Illinois, and because it is experienced with the distribution of both printed maps and digital data via the Internet.

Gas flares at the Salem oil field, Salem, Illinois.

The ISGS will use this information to respond to the many requests it receives for pipeline-related information from Illinois governmental agencies, emergency response agencies, agricultural concerns, independent oil and gas producers, urban and regional planners, and the general public.

DOQ Map Server Wins Award

The Illinois Digital Orthophoto Quadrangle (DOQ) map server has recently received a third place award from the Geography Network Challenge, a national program sponsored by the National Geographic Society and Environmental Systems Research Institute (ESRI). The Geography Network program encourages the development of the infrastructure that allows users to publish and share a wide variety of geographic information systems (GIS) applications on the Internet. The Geography Network Challenge award is a strong acknowledgment of the value of the Illinois DOQ program and presents the Illinois DOQ program, the Illinois Natural Resources Geospatial Data Clearinghouse, and the ISGS in a very positive light.

The Illinois DOQ map server is online and part of the Illinois Natural Resources Geospatial Data Clearinghouse (www.isgs.uiuc.edu/nsdihome/). Currently, 3,670 DOQ files (about 90% of the state) are online and free for download. Sixty-two complete Illinois counties are available online. Compressed DOQs, in four projections, are also available on CD-ROM for twenty-six Illinois counties.

DOQs combine the image characteristics of an aerial photograph with the geometric qualities of a map. These true image maps permit direct measurement of the distances, areas, angles, and other detailed relationships between ground features. In a digital format, orthophotography can be used as a geometrically accurate base map for large-scale mapping projects or to assist in the assessment of local and regional problems and resource management.

Chris McGarry (left) and Sheena Beaverson hold the third place award they received from the Geography Network Challenge for their accomplishments in putting together the ISGS digital orthophoto quadrangle map server.

Tazewell County Maps

Tazewell County has contracted with ISGS staff to produce a set of new geologic maps at a scale of 1:62,500 (1 inch = about 1 mile) to assist the county in making land use decisions. This work is now in progress. The geologic maps should provide a basis for long-term planning, environmental protection, and economic development issues. An important issue of present concern is the siting of new waste disposal facilities in the county.

The map products will be based on information from existing drilling records and well logs, field notes, existing maps, and other data available in ISGS records. In addition, other applicable records will be included, such as those from Tazewell County, Illinois Department of Transportation, and other agencies and companies. Only limited fieldwork will be conducted, and no drilling is planned. Scientific review and quality assurance will ensure the highest possible quality of map products from these data. The ISGS will then prepare digital versions of each map and will provide the digital geologic map databases to Tazewell County.

The map set will include maps of surface topography, surface slope, and shaded relief of the land surface; data point location; bedrock topography; extent and type of glacial deposits; thickness of glacial deposits; distribution of bedrock units; and potential for aquifer contamination.

On the right, Joel Dexter, ISGS photographer, on a field assignment north of Urbana photographing an environmental site assessment study by Charles Dolan and Mark Hart.

Publishing: The Challenge of Change

With the retirement of the ISGS in-house printer and the closing of the ISGS print shop at the end of April 2000, the Publishing, Design, and Photography section of the Survey moved to take advantage of the highly competitive commercial printing environment in Illinois. Technological advances in printing over the past decade now make it possible for publishers such as the ISGS to transmit publications as electronic files to the printer, who can often use them directly, producing high-quality publications without the costly step of making negatives. The cost of additional colors on print publications has also decreased in recent years because of technological advances.

For several years, graphic artists and editors at the Survey have been producing publications using the computer, and so the staff easily made the transition from producing camera-ready paper copy to producing printer-ready electronic files. As in the past, the artists are also familiar with converting electronic publication files to PDF and HTML formats for posting on the Internet. Publications are archived electronically, saving storage space and improving access—to the entire publication or to portions of it, such as a map or illustration.

Graphic artists (left to right) Pam Carrillo and Dan Byers check the elements on a new map. Cindy Briedis, Jackie Hannah, and Mike Knapp work together to solve a design problem.

Another boost to ISGS publishing in 2001 is the acquisition of new digital equipment that complements existing equipment. The digital camera makes it possible to take photographs, preview them "on the spot" and reshoot if needed, download the photos directly to the computer, edit them, and transmit them wherever they are needed. This process also saves the time and cost of film processing and scanning of photographs. ISGS staff continue to explore ways to improve the publishing process and realize the potential of versatile electronic formats.

"Publishing" in the twenty-first century, however, doesn't just mean print products. For example, HTML Web documents are created to be read online—with "screen" the consideration rather than "page." Video and CD-ROM formats that incorporate video streams and other special effects are also being developed. Recent software developments allow these kinds of products to be created much more cost effectively than in the past. A CD-ROM product for the Central Great Lakes Mapping Coalition that incorporates video and other effects is under way.

Various field activities and projects of the ISGS geologists are being digitally documented, both with the camera and videocamera, to build a digital archive that can be used in multiple applications.

Attractive, multimedia products are expected to be especially useful to explain the importance of geology to legislators, planners, citizen groups, educators, students, and others.

Standardizing Identification of Public Water-Supply Wells

A universal well identification system is being adopted by four Illinois state agencies. A standardized numbering system, applied to a digital database, will allow universal searching of the geologic and hydrologic data of Illinois Department of Public Health (IDPH), Illinois Environmental Protection Agency (IEPA), ISGS, and the Illinois State Water Survey (ISWS).

The identification numbering system being adopted is the American Petroleum Institute (API) number, which has been used by the ISGS in its water-well databases since 1952. In 1997, ISGS began entering its API numbers into the ISWS database. The API identification number is a unique identifier for each well or borehole and contains state, county, and well identifiers plus a well version number.

The ISGS will assign API numbers to active and abandoned public water-supply wells in the IEPA and IDPH databases. In most cases, well records must be reviewed for locational, well depth, and other data to avoid applying different identification numbers to the same well shown in different databases.

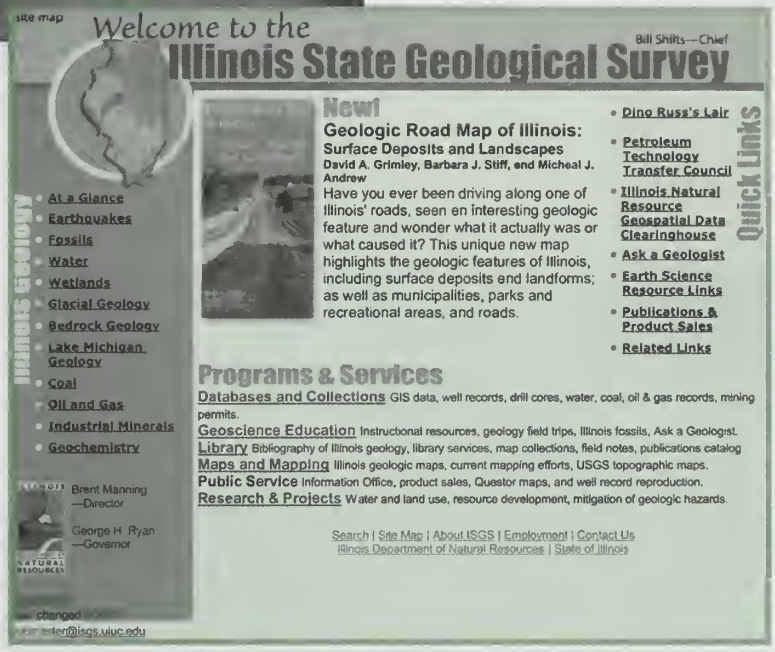
Web Site Redesign and Reorganization

Watch this space: http://www.isgs.uiuc.edu/. Changes are coming soon that should make it easier for users to find the information they need on the ISGS Web site. Goals of the redesign and reorganization of the site are to make it more user-friendly and more consistent in appearance and structure. In addition, the redesigned site will comply with standards set by the Illinois Department of Natural Resources and the Americans with Disabilities Act. All design elements are tested to ensure that the site will be accessible and attractive using the "average" computer configuration with the most popular software browsers.

The new, quick-loading home page features quick links to frequently accessed information, including the Petroleum Technology Transfer Council, the Illinois Natural Resources Geospatial Data Clearinghouse, publications and products sales, earth science resource links, "Ask a Geologist," and Dino Russ's Lair. Time-sensitive and hot topic features will be highlighted. The Programs and Services area will link to mapping information, geoscience education topics, research projects, databases and collections, library, and public service information. Other information will be listed under topical categories.

The ISGS Web Team during a meeting to approve the final home page redesign. From left: Robert White, Sheena Beaverson, Jennifer Ousley, Sally Denhart (chair), Cheryl Nimz, Cindy Briedis, Mary Krick, and Hue-Hwa Hwang. Not pictured are Marie-France Dufour, Kathy Henry, Brian Huff, Russ Jacobson, Hannes Leetaru, Mary Mushrush, Dan Nelson, and John Steele.

The prototype for the home page is nearly complete and ready for ISGS review prior to posting on the Web. Review and redesign of secondary pages will follow. Existing secondary pages and proposals for new pages will be examined to ensure that they maintain quality and scientific standards of the ISGS; avoid copyright problems, duplication of effort, or promotion of commercial interests; and maintain the security of the ISGS network.



The new ISGS home page was designed to help all users find what they are looking for faster and more easily.

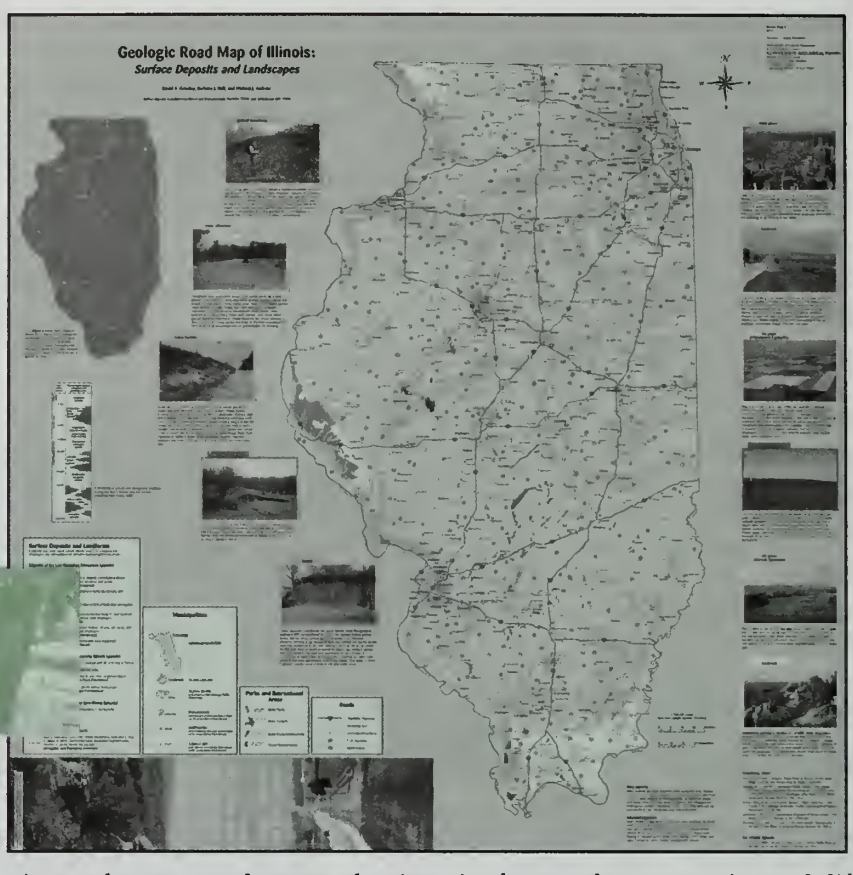
Finding Publications on Illinois Geology

It's easier to research topics relating to Illinois geology since the printing this year of Bulletin 105, *Bibliography and Index of Illinois Geology, 1966–1996*. The publication updates and continues ISGS Bulletin 92, *Bibliography and Index of Illinois Geology through 1965*. Eleven titles are included in the new publication that were published prior to 1966 but that did not appear in Bulletin 92.

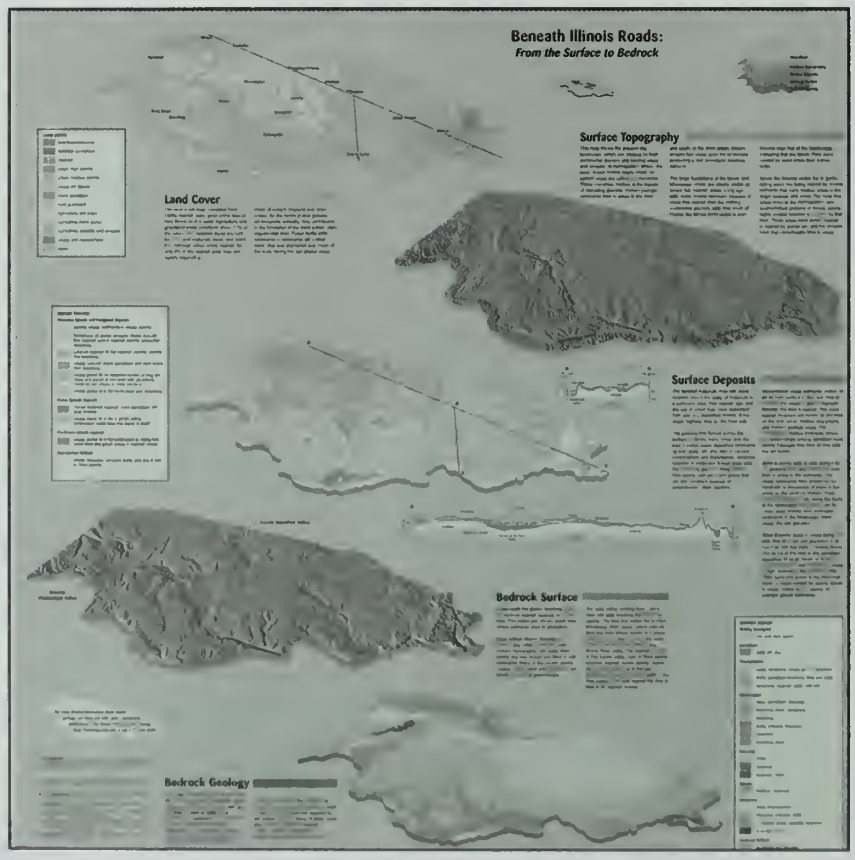
Bulletin 105 includes citations for all ISGS fields of research, including geology, groundwater, industrial minerals, petroleum, coal, environmental geology, geochemistry, and geophysics. Monographs, journal articles, conference proceedings, theses, maps, guidebooks, and reports are among the types of publications cited. All listed citations pertain to Illinois geology.

The initial part of the publication is the bibliography, arranged alphabetically by author surname and, secondarily, within identical authorship, by date. The index that follows includes both subjects and locations. The bibliography and index is also available on the ISGS Web site.

Traveling Illinois with the Geologic Road Map

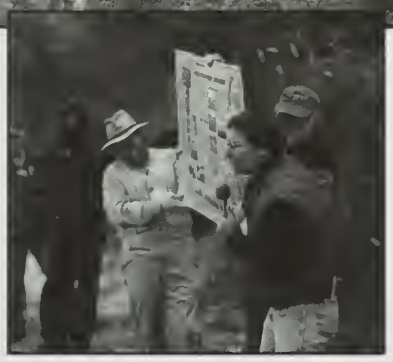


A popular new road map makes it easier for people to recognize and differentiate the geology of the state. The two-sided *Geologic Road Map of Illinois: Surface Deposits and Landscapes* is packed with usable information. The first side of the map relates the geology of Illinois to major highways and cities in the state. Explanatory text is color-coded to geologic features, making it simple to find out more about the geology of any geographic location in the state. The second side of the map provides a three-dimensional view of what lies beneath Illinois roads, from land surface to bedrock.



Field Trips Go from Top to Bottom of State

This year's ISGS Geological Science Field Trip excursions took participants to both ends of the state. The two fall trips to Illinois Beach State Park in Lake County allowed trip participants to travel across the only part of Illinois' Lake Michigan shoreline that remains uninhabited and exposed to wind and waves and to walk through the last remaining concentration of coastal wetlands and dunes in Illinois. Day trippers learned how geologic processes affect the park and the ways that shore defense structures, harbors, and other human activities interact with and affect the natural shoreline processes at the park. The dynamics of nearshore coastal erosion and deposition interact to pose one of the greatest challenges to coastal management anywhere in the Great Lakes system.



Top: Field trip participants stand near the mouth of the Dead River at Illinois Beach State Park. Left: Wayne Frankie (left) and Mike Chrzastowski use the *Chicago's Underwater Landscape* poster to illustrate an explanation of Lake Michigan's lake bottom and shoreline

A father and his child take a few moments to rest at a field trip stop.

The two spring trips were held at Garden of the Gods Recreation Area, Shawnee National Forest, in Saline, Gallatin, Pope, and Hardin Counties. The field trip allowed participants to view and walk among many interesting rock formations, cliffs, and exposures deposited during the Pennsylvanian and Mississippian Periods. The hilly topography, a result of tectonic uplift and the absence of glaciation, contains large natural ecosystems relatively unchanged by human activity. Participants were able to see up close the sandstone glades, upland forests, deep ravines, and distinctive plant species that have persisted since preglacial times.

Left and right: Rock formations at Garden of the Gods Recreation Area. Center: A family looks for mineral specimens at Lee Mine, an abandoned fluorspar mine.

This year's field trips were successful in raising awareness of the environmental and geological issues surrounding these two unique areas of the state. Each of the four trips had about 150 participants, including teachers, students, families, and rock and mineral enthusiasts. The ISGS scientists presented information about the geology of the areas and encouraged participants to ask questions. Field trip guidebooks provided additional information about the area and the route.

Near and Far Sciences in Illinois

Now in its fifth year, the ISGS Near and Far Sciences program continues to help make geology a robust part of the Illinois science curriculum. A total of 100 teachers participated in workshops in the Chicago area this year. Interest in the Rock Island area is especially high, with two workshops being held (and requests for more); other workshops were conducted in La Salle-Peru and Alton.

The program, partially funded by the Illinois State Board of Education, was created when geology was added to the Illinois Learning Standards for Science in 1997. A team of several ISGS geologists from various disciplines work together to present workshop materials and interact with teachers. The successful program has inspired other teacher training efforts, such as the ENTICE and GeoExplorer programs.

During the two-day workshops, teachers spend one day in the classroom listening to lectures, watching demonstrations, and participating in hands-on geologic activities. The second day of the workshop is spent on a field trip to an area of local interest. All activities and materials show the relevance of Illinois geology to the lives of teachers and students.

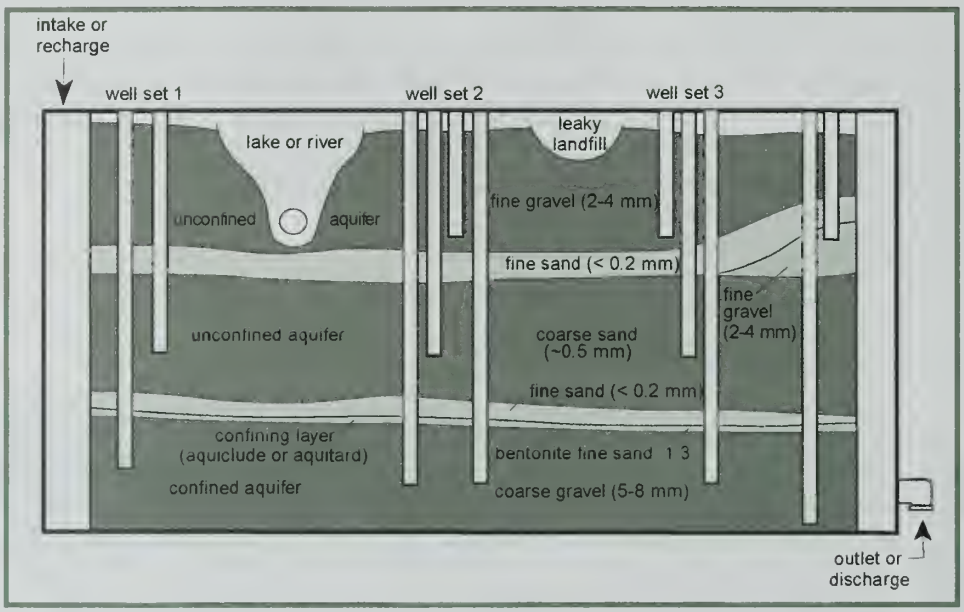


Diagram from the *ISGS GeoActivity Notebook* of the groundwater flow model that can be used to demonstrate (1) how groundwater moves through different kinds of unconsolidated materials, (2) how groundwater and surface water can be contaminated, and (3) how aquifer capacity and water production rates are related.

The classroom portion of the workshop was centered around the activities in the award-winning *ISGS GeoActivities Notebook* produced last year; the notebook contains additional activities teachers can use later in their own classrooms. Teachers who have already used the *ISGS GeoActivities Notebook* are eagerly awaiting the first notebook supplement, now in the planning phase. Teachers have requested easy-to-use information on radiocarbon dating, caves, plate tectonics, glaciers, and chemistry.

ENTICE

The Environment and Nature Training Institute for Conservation Education (ENTICE), a new teacher-training program instituted by the Illinois Department of Natural Resources, requested ISGS speakers for its two-day workshop held in Wildlife Prairie Park west of Peoria. Each of the four workshops attracted thirty-five K–12 teachers from a variety of disciplines and from locations around the state. Scientists know that the teachers are a

crucial link in translating technical information into phrases, words, and concepts students can understand.

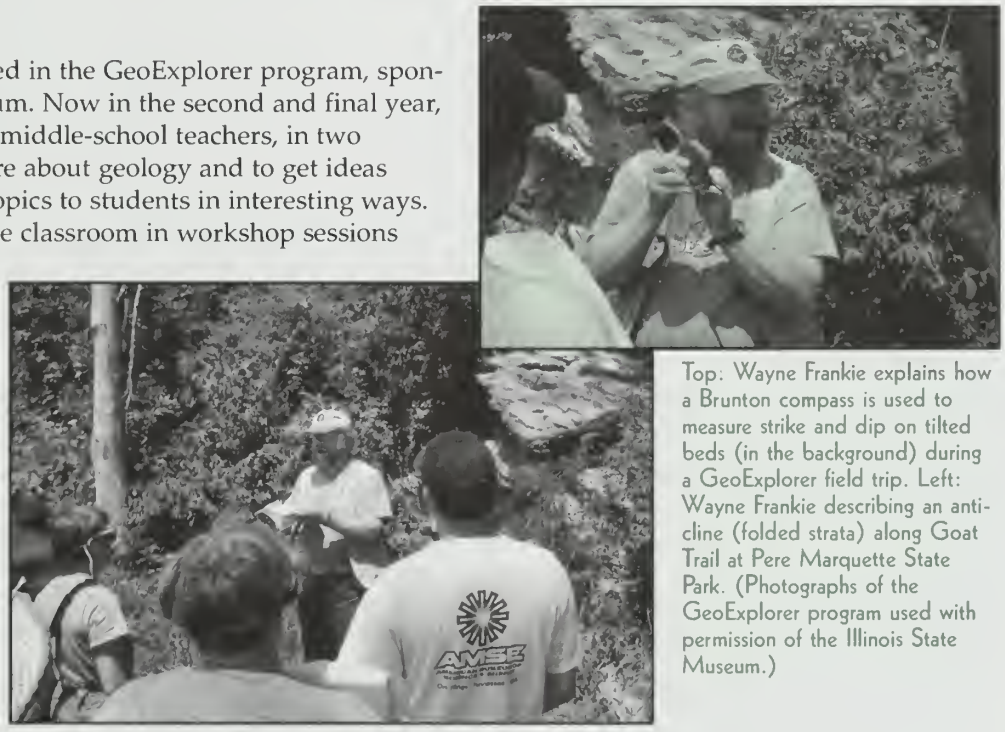
Geologists helped give teachers an idea of how Illinois was formed, with an emphasis on the effects of glaciers, so that the teachers would have the geological basis for presentations that followed on topics such as wetlands and woodlands.

Glacial history has played a major role in shaping the state's topography, soil materials, the distance from the surface to bedrock, and the distribution of plants and animals. Teachers learned that ecosystems are not composed solely of what is above the land surface; ecosystems also affect—and are affected by—what is in the subsurface.

Top left: Wayne Frankie (right) explains the effect glaciers had on Illinois geology to Illinois K–12 teachers during an ENTICE workshop. Above: Teachers prepare to participate in an outdoor exercise demonstrating how moraines are formed. Left: Teachers work together to identify rock and mineral specimens.

GeoExplorers

ISGS geologists again participated in the GeoExplorer program, sponsored by the Illinois State Museum. Now in the second and final year, the program has given about 30 middle-school teachers, in two groups, a chance to find out more about geology and to get ideas about how to present geologic topics to students in interesting ways. The teachers spent one day in the classroom in workshop sessions learning about plate tectonics, geologic time, fossils, and other topics. This day was followed by one day of field trips to Alton and Pere Marquette State Park. The final half-day was spent on the computer, so teachers could become more comfortable using computer technology to access and use geologic information.



Top: Wayne Frankie explains how a Brunton compass is used to measure strike and dip on tilted beds (in the background) during a GeoExplorer field trip. Left: Wayne Frankie describing an anticline (folded strata) along Goat Trail at Pere Marquette State Park. (Photographs of the GeoExplorer program used with permission of the Illinois State Museum.)

Active Projects, 2000-2001

Applied Geochemistry

Viruses, Antibiotics, Bacteria, and Nutrients in Groundwater at Swine Facilities, I.G. Krapac.

Chief's Office

1:24,000 Geologic Mapping of the Kankakee Candidate Site for a South Surburban Airport, R.C. Berg, E.D. McKay.

Kane County Geologic Mapping Project, R.C. Berg.

Geological Characterization of Watersheds, J.H. Goodwin, M.L. Barnhardt, R.A. Bauer, P. Cookus, J. Hannah, V.C. Ipe, D. A. Keefer, M.M. Killey, T.H. Larson, D.E. Luman, R.J. Rice, R.C. Vaiden, C.P. Weibel, C.K. Nimz, S. Medlin.

Illinoian Glacial Landforms, Processes, and Sediments in South-Central Illinois, E.D. McKay, C.S. McGarry, L.R. Smith.

Coal

Availability of Colchester Coal, R. Jacobson, C.P. Korose, S.R. Elrick.

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From the People of Illinois

"In September of 2001 we drilled and hit water at 14 ft. [The well] produces 15 gallons per minute. It is a location which neither I nor the previous owners of the property would have ever dreamed of drilling. I'm here to praise the work of Tim Young and Curt [Blakley]; without them I would never have found water. They are both outstanding professionals who do excellent work."
—Stefano Terracina, Odell

"On October 6 our Park District, in partnership with the Kane County Forest Preserve, offered a field trip on the geology of Northern Kane County. One of your employees, Brandon Curry, very graciously agreed to lead the trip even though it was on a weekend. . . . He planned and presented a trip that went off without a hitch, was put in a way that the layman could understand, and which was fun. The participants loved it and were sorry to see it end."
—Mary Ochsenschlager, St. Charles Park District, St. Charles

"My husband and I had been on the waiting list after three dry holes had put off our building a new house this fall. We were a bit frustrated, but understand the importance of having water BEFORE building a beautiful new home that you can't shower in. . . . Curt [Blakley] and Mary [Mushrush] came out and did a great job. . . . Please let Curt and Mary and Tim [Young] know how much we valued the service. . . ."
—Gary and Ronda Sullivan, Homer

"I am writing this letter to commend . . . Tonia [Vaughn]. I contacted her the week of August 20, and she was very helpful in finding the information that I was needing. . . . please tell her how much I appreciated all of her help!"
—Tina Blackburn, Ingalls Park Subdivision Improvement Association, Inc., New Lenox

"I also attended the field trip to Illinois Beach State Park that the ISGS sponsored on Oct. 28, 2000. Both times I was impressed with . . .the content and presentation of the topic. . . . I was blown away at the number of people [who] attended . . . . The main lecturer, Mike Chrzastowski, was so enthused about the Zion, Beach Park area, I wanted to learn more. He was very good at answering questions so everyone, even the children, would understand. I hope these [field trips] continue. . . . [The field trip] is a prime example of a group that works well together to produce an outstanding product."
—Rita Keefe, Villa Park

"I was extracting historical aggregates production data from ISGS files in Champaign last week; the data were originally from the USBM. Subhash Bhagwat and Don Mikulic were very generous with their time and resources. . . . We are grateful to ISGS for retaining the valuable production data archives, and we hope you will be able to continue to retain them. We also appreciate the help of your staff, especially during such a trying time. Subhash even extended the offer of his home if Robyn Tapper and I had not been able to make motel arrangements."
—Lucy McCartan, U.S. Geological Survey

". . . Wayne Frankie, Bob Vaiden, and Sallie Greenberg helped from the very beginning of the grant with the planning stages and then conducted workshops both last summer and this summer which the teachers reacted to very positively. Last winter, Dave Gross provided a keynote address that enthralled the teachers—they all wanted to pack their bags and leave for Antarctica. This summer, Joe Devera followed with a keynote address on Illinois fossils—paving the way for an enthusiastic hunt for fossils in the field the next day. Your Survey scientists made a very positive impact on Illinois teachers from across the state."
—Judith Washburn, Program Coordinator, GeoExplorer Institute, Illinois State Museum

"On Wednesday, May 23rd, 2001, Dr. William R. Roy took time out of his busy schedule to provide training in Contaminant Sorption and Degradation in Solute-Transport Modeling to Illinois EPA Bureau of Land employees. Let me take this opportunity to formally thank him for his time and expertise. . . . Dr. Roy's presentation covered several topics and concepts, and successfully targeted a diverse audience with differing backgrounds and educations. Feedback indicates that Dr. Roy's expertise will be a valuable resource in the years to come."
—William C. Child, Chief, Bureau of Land, Illinois Environmental Protection Agency

"We would like to let you know what a great job Tim Young and Curt Blakley did for us, by helping to find water at our business. We know it was a very cold day in November when Curt came to survey—VERY COLD. . . . We drilled down to bedrock as they said and successfully hit water. Please let [them] know what a fine job they both did."
—Dennis D. Carls, Sales Manager, Sun Ag Inc.

"It was my pleasure to attend the NFSI geology workshop taught by Wayne Frankie at Illinois Valley College. . . .I was very impressed by his kindness and patience in dealing with a group of teachers. He has a way of making very complex concepts easy to understand. . . I appreciate the ISGS providing this valuable learning experience."
—Erwin B. Litherland, Atlanta

"The intent of this letter is to express our thanks and appreciation for the work that Hannes [Leetaru] and the ISGS put into the above mentioned report. . . . It is my hope that the ISGS will continue to be able to obtain the necessary funds to continue this type of research. It not only helps the industry, but also mineral owners who will hopefully benefit from more prudent and efficient development and production of their oil and gas minerals."
—Kevin W. Reimer, Finite Resources, Ltd.

"Dear Bill, Just a note to thank you again for sending several people to Dr. Howard [Elementary School] for a wonderful family fun and learn evening focusing on geology. I continue to hear many positive comments from our students and their parents."
—Christy Brinkley, Principal, Dr. Howard School, Champaign

For more information

Illinois State Geological Survey
615 East Peabody Drive,
Champaign Illinois 61820
217/333-ISGS
isgs@isgs.uiuc.edu
http://www.isgs.uiuc.edu

Chief's Office
William W. Shilts, Chief
217/333-5111
shilts@isgs.uiuc.edu

E. Donald McKay III, Chief Scientist
217/333-0044
mckay@isgs.uiuc.edu

Richard C. Berg, Director
Geologic Mapping Program
217/244-2776
berg@isgs.uiuc.edu

Jonathan H. Goodwin, Assistant to the Chief for Strategy and Planning
217/333-5855
goodwin@isgs.uiuc.edu

Jennifer K. Hines, Implementation and Communication Coordinator
217/244-2410
hines@isgs.uiuc.edu

Gerald E. Glogowski, Head
Administrative Group
217/244-2403
gglo@isgs.uiuc.edu

Michael V. Miller, Head
Center for Transportation and the Environment
217/333-7093
miller@isgs.uiuc.edu

Robert J. Finley, Head
Economic Geology Group
217/244-8389
finley@isgs.uiuc.edu

Beverly L. Herzog, Head
Environmental Geology Group
217/244-2788
herzog@isgs.uiuc.edu

Marie-France Dufour, Head
Information Delivery Group
217/333-5115
dufour@isgs.uiuc.edu

Applied Geochemistry
James B. Risatti
217/333-5103
rissati@isgs.uiuc.edu

Business and Financial Services
Debra A. Griest
217/244-2390
griest@isgs.uiuc.edu

Coal
Russell J. Jacobson
217/244-2426
jacobson@isgs.uiuc.edu

Coastal Geology
Michael J. Chrzastowski
217/244-2194
chrzasto@isgs.uiuc.edu

Computing Services
PC Installation/Software
Kerry M. Riley
217/244-2524
riley@isgs.uiuc.edu

Network/Work Stations, Web Page Development
Sally Denhart
217/333-5102
denhart@isgs.uiuc.edu

Drilling and Vehicle Operations
Chris R. Wilson
217/333-6849
wilson@isgs.uiuc.edu

Energy and Environmental Engineering
Massoud Rostam-Abadi
217/244-4977
massoud@isgs.uiuc.edu

Engineering Geology
Robert A. Bauer
217/244-2394
bauer@isgs.uiuc.edu

Environmental Site Assessments
Anne L. Erdmann
217/244-2502
erdmann@isgs.uiuc.edu

Geological Samples Library
217/333-3567

Geological Records Unit
217/333-5109

Geoscience Outreach and Public Field Trips
Wayne T. Frankie
217/244-2427
frankie@isgs.uiuc.edu

Geospatial Analysis and Modeling
Robert J. Krumm
217/333-4085
krumm@isgs.uiuc.edu

Groundwater Geology
Edward Mehnert
217/244-2765
mehnert@isgs.uiuc.edu

Human Resource Office
Linda M. Cunningham
217/244-2402
cunning@isgs.uiuc.edu

Industrial Mineral and Resource Economics
Zakaria Lasemi
217/244-6944
lasemi@isgs.uiuc.edu

Information Office, Maps, Publications Sales
217/244-2414

Isotope Geochemistry
Chao-Li (Jack) Liu
217/244-2192
jliu@isgs.uiuc.edu

Library
217/333-5110
library@isgs.uiuc.edu

Maintenance, Operations, Design
Joseph S. Kaczanowski
217/244-5006
joek@isgs.uiuc.edu

Oil and Gas
Beverly Seyler
217/244-2389
seyler@isgs.uiuc.edu

Petroleum Technology Transfer Council
Midwest Regional Office
Richard J. Geier
217/244-9337
geier@isgs.uiuc.edu

Publishing, Design, and Photography
Cheryl K. Nimz
217/265-5194
nimz@isgs.uiuc.edu

Public Information
Mary P. Krick
217/244-2787
krick@isgs.uiuc.edu

Quaternary Geology
Ardith K. Hansel
217/333-5852
hansel@isgs.uiuc.edu

Sedimentary and Crustal Processes
Dennis R. Kolata
217/244-2189
kolata@isgs.uiuc.edu

Wetlands Geology
James J. Miner
217/244-5786
miner@isgs.uiuc.edu